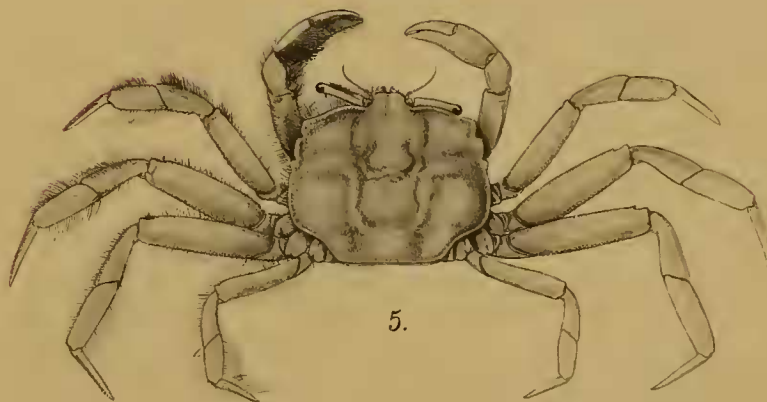
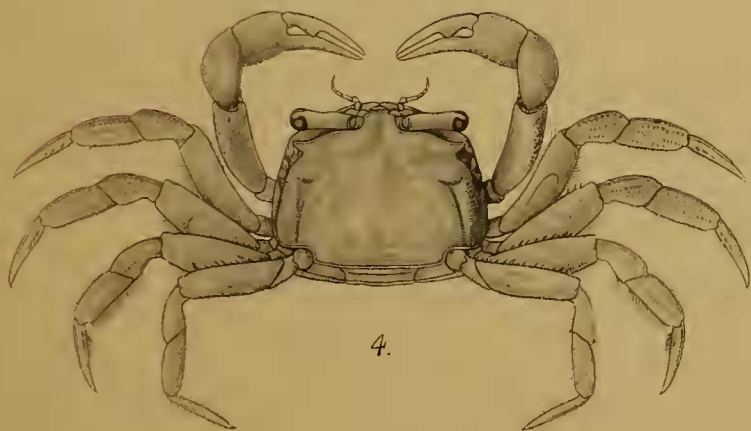
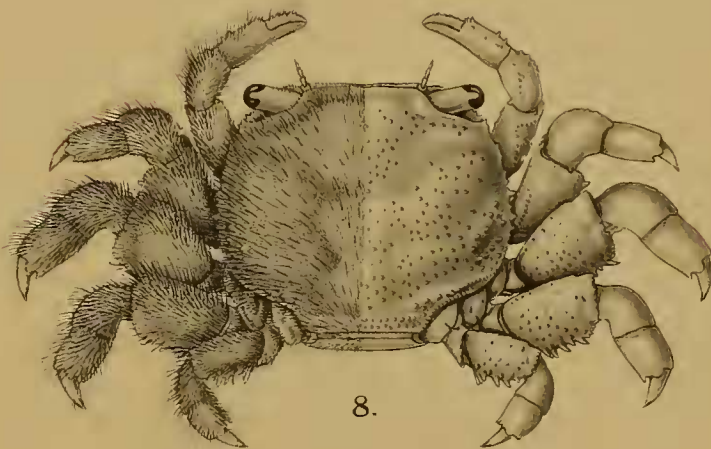
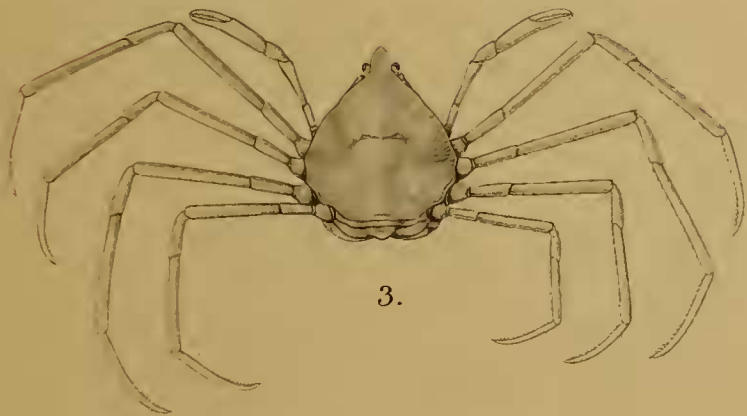
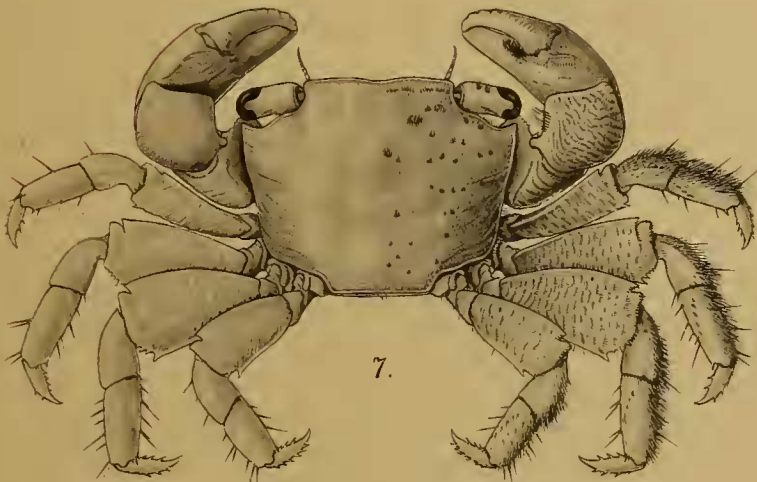
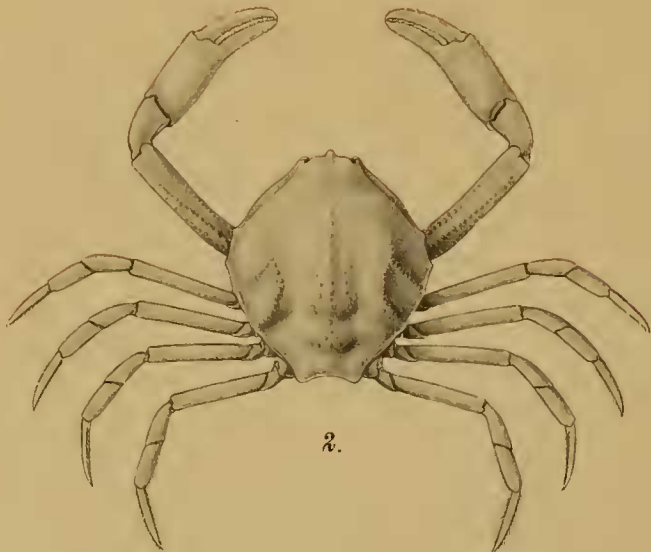
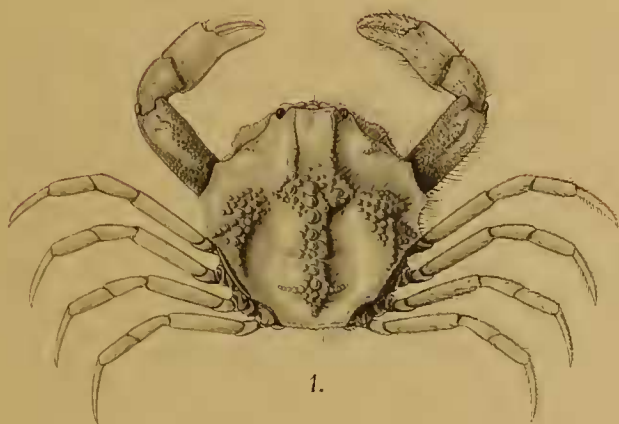


EXPLANATION OF PLATE XII.

- FIG. 1.—*Ebalia malefactorix*, sp. nov., male $\times 2\frac{1}{2}$ (p. 209).
,, 2.—*Philyra alcocki*, sp. nov., male $\times 2\frac{1}{4}$ (p. 212).
,, 3.—*Elamena (Trigonoplax) cimex*, sp. nov., female $\times 2\frac{1}{2}$ (p. 216).
,, 4.—*Dotilla pertinax*, sp. nov., male $\times 4$ (p. 222).
,, 5.—*Macrophthalmus gastrodues*, sp. nov., male $\times 1\frac{1}{3}$ (p. 228).
,, 6.—*Camptandrium sexdentatum*, Stimpson, young male $\times 5\frac{1}{3}$ (p. 236).
,, 7.—*Sesarma batavicum*, Moreira, male $\times 3\frac{1}{2}$ (p. 238).
,, 8.—*Leipocten sordidulum*, gen. et sp. nov., female $\times 4\frac{3}{4}$ (p. 244).



EXPLANATION OF PLATE XIII.

Callianassa (Callichirus) maxima, A. Milne-Edwards (p. 253).

- FIG. 1.—Anterior part of carapace, rostrum, eyes, etc. of the specimen from Madras: $\times 2.5$.
,, 2.—Large chelipede of the same specimen, external view: $\times 1.25$.
,, 3. Ditto ditto internal view: $\times 1.25$.
,, 4. Ditto from the Chilka Lake, external view: $\times 1.58$.
,, 5.—Last abdominal somite, telson and uropods of the specimen from Madras: $\times 1.9$.

Upogebia (Upogebia) heterocheir, sp. nov. (p. 257).

- FIG. 6.—Anterior part of carapace, rostrum, eyes, etc.: $\times 6.3$.
,, 7.—Last abdominal somite, telson and uropods: $\times 5$.

Pontophilus hendersoni, sp. nov. (p. 261).

- FIG. 8.—A male, dorsal view: $\times 5$.

Urocaris indica, sp. nov. (p. 275).

- FIG. 9.—An ovigerous female, lateral view: $\times 5$.

Periclimenes demani, sp. nov. (p. 279).

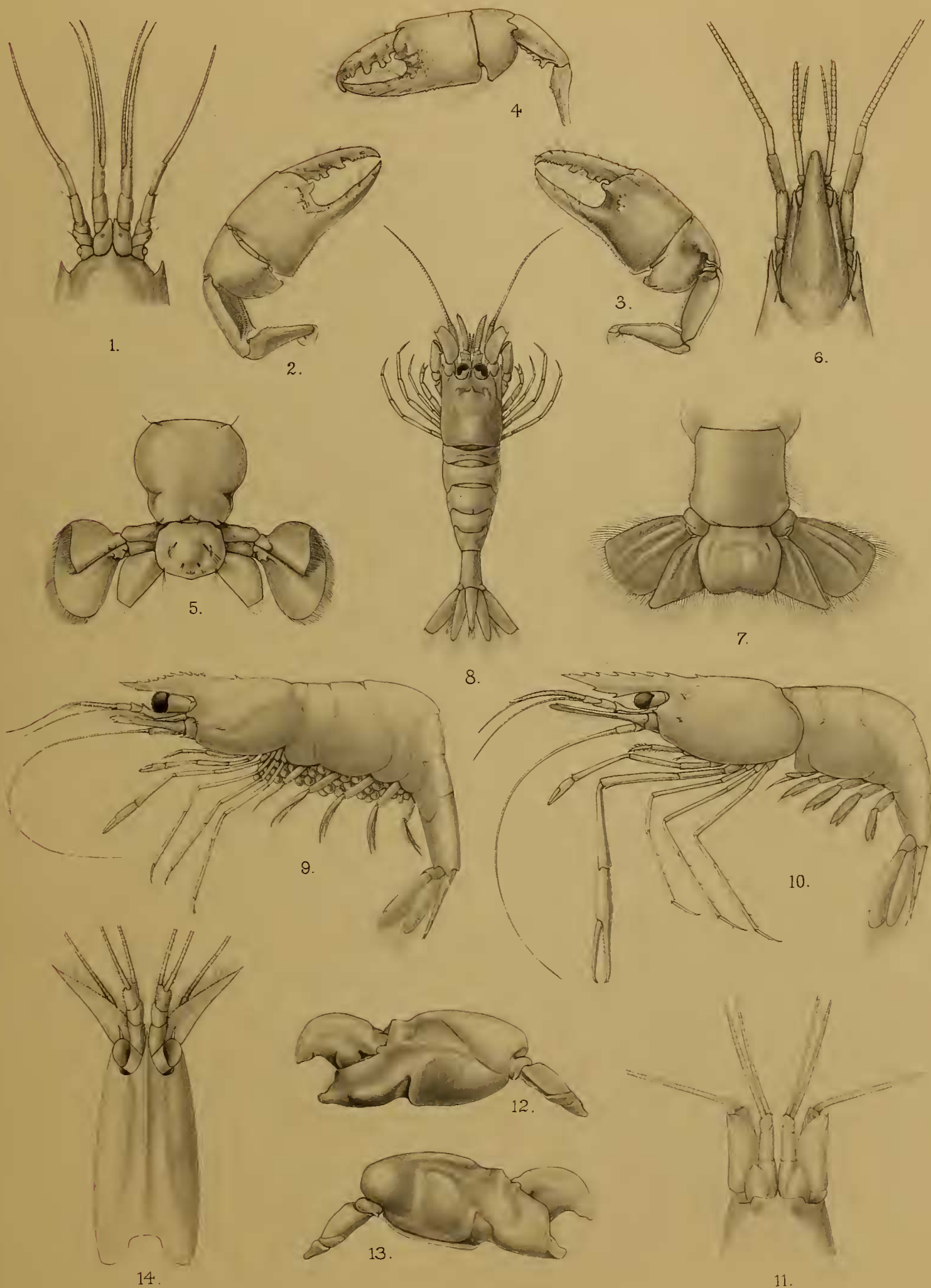
- FIG. 10.—A male, lateral view: $\times 4.4$.

Alpheus paludicola, sp. nov. (p. 303).

- FIG. 11.—Anterior part of carapace, rostrum, etc.: $\times 5$.
,, 12.—Large chelipede, external view: $\times 3$.
,, 13. Ditto , internal view: $\times 3$.

Leptochela aculeocaudata, Paulson (p. 311).

- FIG. 14.—Carapace of a female, with eyes, antennules, etc. in dorsal view: $\times 10$.



FAUNA OF THE CHILKA LAKE

CRUSTACEA DECAPODA.

By STANLEY KEMP, B.A.

(Plates XII, XIII.)

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CRUSTACEA DECAPODA.

By STANLEY KEMP.

The Crustacea Decapoda form an important part of the fauna of the Chilka Lake and comprise, including casual visitors, fifty-four species. At least thirty-nine are permanent inhabitants and it is not a little surprising that so large a number of forms should have adapted themselves to the peculiar physical conditions that prevail in the lake-system.

The results of our observations on the physical environment of the fauna have already been discussed in detail in the Introduction to this volume: but it will be well to recapitulate here one or two of the more salient features.

The lake, which lies on the coast of Orissa, may be divided into two regions, firstly the main area, a large lagoon fed by rivers from the northern end only and even in the flood-season nowhere more than 15 ft. in depth, and secondly the outer channel, some twelve miles in length and but little deeper than the main area, which forms a communication with the sea. The bottom of the main area is mud, or mud with a small admixture of sand; in the outer channel it is composed of muddy sand in the inner portion and of clean sand nearer the mouth. It is, however, the great seasonal changes in salinity that constitute the most noteworthy feature of the physical conditions. In August, towards the close of the rainy season, the level of the lake is considerably higher than at other times of the year, owing to the great volume of fresh water which is poured into it from the north. The fresh water expels most of the salt water from the lake, with the result that during August and the two succeeding months the northern portion of the main area and the whole of the outer channel up to the sea-mouth are completely filled with water that shows no trace of salinity. The southern end of the lake always remains slightly brackish, though during these months it is far less saline than at other times of the year. By the end of October the floods begin to subside and later, under certain conditions of wind and tide, salt water from the Bay of Bengal enters the outer channel and the main area. For a considerable part of the year the outer channel remains filled with water of the same density as that of the Bay of Bengal in the vicinity of the sea-mouth (sp. gr. 1.0265). In the main area it is improbable that so high a density is ever reached, for a certain amount of fresh water is constantly entering the lake from the north. According to our observations the specific gravity does not rise above 1.0150.

It is evident, then, that species that permanently inhabit the outer channel can withstand seasonal alterations of salinity varying from that of fresh water to that of water as salt as the sea in the neighbourhood of the lake, while those that exist in

the main area throughout the year can survive in a medium varying from fresh water to water of specific gravity 1.0150.

The species of Decapoda found in the course of our investigations in the Chilka Lake are listed on pp. 204, 205. Each species is classified biologically as a permanent inhabitant, a seasonal immigrant, or a casual visitor; the range of salinity which it can withstand in the lake is noted and indication is made of its habitat, whether found in the main area or the outer channel, with a brief note on its further distribution.

About 60 per cent of the total number of species are able to exist throughout the whole range of salinities that occur.

The permanent inhabitants, those that are found in the lake throughout the year, form the most important part of the Decapod fauna and comprise the great majority of the species obtained. Among them, as might be expected, are representatives of a number of families known to inhabit brackish water. Such are the Hymenosomatidae, Grapsidae, Ocypodidae, Geocarcinidae, Portunidae, Atyidae and Penaeidae. Several of the genera met with were, however, known hitherto only from the sea and precise indications of the salinity that the others are able to endure has in most instances been lacking. The Leucosiidae and Xanthidae are marine types whose presence in fresh and brackish water is unexpected and this is also true of the majority of the Alpheidae¹, the Palaemonid genera *Urocaris* and *Periclimenes* and the planctonic Sergestid, *Lucifer*.

The only representatives of freshwater genera that can be classed as permanent inhabitants are the two species of *Caridina*.

So far as our present knowledge goes, the following species are confined to estuarine tracts and lagoons, that is to say, to waters communicating directly with the sea, but of low or variable salinity:—

<i>Ebalia malefactorix.</i>	<i>Leipocten sordidulum.</i>
<i>Philyra alcocki.</i>	<i>Clibanarius olivaceus.</i>
<i>Elamena (Trigonoplax) cimex.</i>	<i>Upogebia (Upogebia) heterocheir.</i>
<i>Macrophthalmus gastrodes.</i>	<i>Periclimenes demani.</i>
<i>Pachygrapsus propinquus.</i>	<i>Ogyrides striaticauda.</i>
<i>Alpheus paludicola.</i>	

No Oxyrhyncha², Dromiacea, Hippidea, Galatheidea, Palinura or Stenopidea were obtained in the lake. Among the Brachygnatha it is singular that no representatives of the Pinnotheridae and Gonoplacidae occur. Many of the species belonging to these two families are mud-dwellers and, judging from the account which Miss Rathbun has given³, they constitute a very important part of the fauna of the inshore waters of the Gulf of Siam.

¹ One member of this family, *Alpheopsis haugi*, is indeed known from a freshwater lake in French Congo (see Coutière, *Bull. Mus. d'Hist. nat. Paris*, 1906, p. 376).

² The family Hymenosomatidae, one species of which occurs in the lake, is sometimes included in this tribe. I have followed Alcock in placing it in the Brachyrhyncha.

³ Rathbun, *Danske Vid. Selsk. Skrift. (7), Naturvid. og. math.*, V, p. 302 (1910).

The species classed as seasonal immigrants are particularly interesting. Of the only crab included in this category, *Gelasimus annulipes*, a well-established colony was found in the outer channel in the salt-water season. The colony inhabited one of the islands in this region and was composed of small and half-grown individuals, some of which were probably hatched in the lake. In the freshwater season, when the floods had raised the water-level of the channel by several feet, making a considerable reduction in the size of the island, we were unable to find any trace of the species. It is evident that with the arrival of the fresh water the colony was either exterminated or was compelled to change its quarters. Unfortunately we were unable to determine whether the appearance of the species in the outer channel is an annual event.

Concerning two other species that are classed as seasonal immigrants, *Palaemon malcolmsoni* and *P. rudis*, we are able to offer evidence of a more satisfactory nature. Towards the close of the monsoon these species are common in the main area and are trapped in large numbers by the Uriya fishermen. Their appearance in the lake is unquestionably an annual event coinciding with the freshwater season. During this period egg-bearing females of *P. malcolmsoni* alone were seen, whereas in the case of *P. rudis* adult males were commonly found together with ovigerous females. Except for a series of small ovigerous females obtained at Satpara in salt water, which I attribute with very considerable doubt to *P. malcolmsoni*, no adult *Palaemon* were found in the lake during the salt-water season and the species are so large and specimens are so numerous during the freshwater period, that it is scarcely possible that we can be mistaken on this point. The adults must therefore migrate to the lake annually from the ponds and streams of fresh water in its vicinity, and it is significant that this migration coincides with the period when the females bear eggs and that in one of the two species it is undertaken only by this sex. The only possible explanation is that the females resort to the lake to hatch out their young in its waters, an explanation which is corroborated in the case of *P. rudis* by the fact that we obtained at different localities, and at all times of the year, young forms that could definitely be associated with this species.

Palaemon lamarrei is also classed as a seasonal immigrant. As in the case of *P. malcolmsoni* only ovigerous females were found; but these were obtained exclusively in the salt-water season, in water of specific gravity varying from 1.008 to 1.011. The species apparently enters the lake for the same purpose as the other two, but apparently prefers brackish water.

The migrations of the Palaemonidae in the Chilka Lake are most remarkable, for all the species are known to occur in fresh water in localities from which access to tidal creeks and lagoons is clearly impossible.

Eleven species we regard as casual visitors to the lake, ten being immigrants from the sea and one from fresh water. In the outer channel in March, when the water was as salt as that of the Bay of Bengal in the vicinity of the lake, *Pontophilus hendersoni* occurred near the sea-mouth, and on the sand-banks in the same

Species.	Permanent inhabitant.	Seasonal immigrant.	Casual visitor.	Specific gravity of water.	Distribution in lake.		Further distribution.
					Main Area.	Outer Channel.	
REPTANTIA							
OXYSTOMATA							
CALAPPIDAE.							
<i>Matuta victor</i> (Fabricius) ..	..	..	X	1.0265	..	X	Indo-pacific.
LEUCOSUDAE.							
<i>Ebalia malefactorix</i> , sp. nov. ..	X	..	..	1.000—1.0265	X	X	Backwaters nr. Madras and at Cochin.
<i>Philyra alcocki</i> , sp. nov. ..	X	..	..	1.000—1.011	X	X	
BRACHYGNATHA							
HYMENOSOMATIDAE.							
<i>Elamena</i> (<i>Trigonoplax</i>) <i>cimex</i> , sp. nov. ..	X	..	..	1.000—? !	..	X	
OCYPODIDAE.							
<i>Ocypoda macrocera</i> , Milne-Edwards ..	X	..	..	1.000—1.0265	..	X	Bay of Bengal; G. of Siam.
" <i>platytarsis</i> , Milne-Edwards ..	X	..	..	1.000—1.0265	..	X	Coasts of Peninsular India; Ceylon.
<i>Gelasimus annulipes</i> , Latreille ..	..	X	..	1.0265	..	X	Indo-pacific.
<i>Dotilla pertinax</i> , sp. nov. ..	X	..	..	1.000—1.0265	..	X	
" <i>clepsydroidactylus</i> , Alcock ..	..	..	X	1.0265	..	X	Coast of Orissa; ? Madras.
" <i>myctiroides</i> , Milne-Edwards ..	..	..	X	1.0265	..	X	Indo-pacific.
<i>Macrophthalmus gastroides</i> , sp. nov. ..	X	..	..	1.000—1.0265	..	X	
GRAPSIDAE.							
<i>Pachygrapsus propinquus</i> , de Man ..	X	..	..	1.000—1.0265	X	X	Gangetic delta; backwaters nr. Madras.
<i>Varuna litterata</i> (Fabricius) ..	X	..	..	1.000—1.0265	X	X	Indo-pacific.
<i>Ptychognathus onyx</i> , Alcock ..	X	..	..	1.000—1.0125	..	X	? Tavoy.
<i>Camptandrium sexdentatum</i> , Stimpson ..	X	..	..	1.000—? !	..	X	Hongkong; backwaters nr. Madras.
<i>Sesarma tetragonum</i> (Fabricius) ..	..	..	X	1.0265	..	X	Indo-pacific.
" <i>batavicum</i> , Moreira ..	X	..	..	1.000—1.0265	..	X	Backwaters nr. Madras; Batavia.
<i>Plagusia depressa tuberculata</i> , Lamarck ..	..	..	X	1.0265	..	X	Indo-pacific.
GEOCARCINIDAE.							
<i>Cardiosoma carnifex</i> (Herbst) ..	X	..	..	1.000—1.0265	..	X	Indo-pacific.
XANTHIDAE.							
<i>Heteropanope indica</i> , de Man ..	X	..	..	1.000—1.0265	..	X	Mergui Archipelago.
<i>Leipocten sordidulum</i> , gen. et sp. nov. ..	X	..	..	1.000—1.0265	..	X	Backwaters nr. Madras.
PORTUNIDAE.							
<i>Scylla serrata</i> (Forskål) ..	X	..	..	1.000—1.0265	X	X	Indo-pacific.
<i>Neptunus pelagicus</i> (Linnaeus) ..	X	..	..	1.000—1.0265	X	X	Indo-pacific.
<i>Thalamita crenata</i> (Latreille) ..	X	..	..	1.000—1.0265	..	X	Indo-pacific.

PAGURIDEA									
PAGURIDAE.									
<i>Clibanarius padavensis</i> , de Man	..	X	..	..	1'000—1'0265	X	X	W. India to New Caledonia.	X
" <i>longitarsis</i> (de Haan)	..	X	..	..	1'0065	X	..	Indo-pacific.	..
" <i>olivaceus</i> , Henderson	..	X	..	..	1'0065—1'010	X	..	Backwaters nr. Madras.	..
<i>Diogenes avarus</i> , Heller	..	X	..	..	1'000—1'0265	X	X	E. Africa to Torres Strs.; ? Mediterranean.	X
COENOBITIDAE.									
<i>Coenobita rugosus</i> , Milne-Edwards	..	..	..	X	1'000—? ¹	..	X	W. Africa; Indo-pacific; W. America.	X
" <i>cavipes</i> , Stimpson	..	..	..	X	1'000—1'0265	..	X	Indo-pacific.	X
THALASSINIDEA									
CALLIANASSIDAE.									
<i>Callianassa (Callichirus) maxima</i> , A. M.-Edw.	..	X	..	..	1'000—1'008	X	X	Madras; Siam (sub-fossil).	X
<i>Upogebia (Upogebia) heterocheir</i> , sp. nov.	..	X	..	..	1'000—1'0265	X	X		X
NATANTIA									
CARIDEA									
CRANGONIDAE.									
<i>Pontophilus hendersoni</i> , sp. nov.	..	..	..	X	1'0265	..	X		X
PALAEMONIDAE.									
<i>Palaemon lamarrei</i> , Milne-Edwards	..	..	X	..	1'007—1'011	X	..	Gangetic delta; Madras.	..
" <i>malcolmsoni</i> , Milne-Edwards	..	..	X	..	1'000	X	..	Gangetic delta; S. India.	..
" <i>rudis</i> , Heller	..	..	X	..	1'000—1'002	X	X	India; Madagascar; E. Africa.	X
" <i>scabriculus</i> , Heller	..	..	..	X	1'011	X	..	India to Celebes.	..
<i>Leander styliferus</i> (Milne-Edwards)	..	..	..	X	1'0265	..	X	Gangetic delta; Burma; Karachi.	X
<i>Urocaris indica</i> , sp. nov.	..	X	..	..	1'000—1'0265	X	X	Backwaters nr. Madras; G. of Manaar.	X
<i>Periclimenes demani</i> , sp. nov.	..	X	..	..	1'000—1'0265	..	X	Backwaters nr. Madras.	X
ALPHEIDAE.									
<i>Ogyrides striaticauda</i> , sp. nov.	..	X	..	..	1'000—1'0265	..	X	Backwaters nr. Madras and at Cochin.	X
<i>Athanas polymorphus</i> , sp. nov.	..	X	..	..	1'000—1'0265	..	X	Port Blair, Andamans.	X
<i>Alpheus crassimanus</i> , Heller	..	X	..	..	1'000—1'0265	X	X	Red Sea to Celebes.	X
" <i>malabaricus</i> , Fabricius	..	X	..	..	1'000—1'0265	..	X	Backwaters nr. Madras; Pt. Blair, Andamans.	X
" <i>paludicola</i> , sp. nov.	..	X	..	..	1'000—1'0265	X	X		X
ATYIDAE.									
<i>Caridina nilotica</i> var. <i>bengalensis</i> , de Man	..	X	..	..	1'000—1'0265	X	X	Gangetic delta to Ceylon; ? Celebes.	X
" <i>propinqua</i> , de Man	..	X	..	..	1'000—1'015	X	X	Northern end of Bay of Bengal.	X
PASIPHAELIDAE.									
<i>Leptochela aculeocaudata</i> , Paulson	..	..	..	X	1'0265	..	X	Red Sea.	X
PENAEIDEA									
PENAEIDAE.									
<i>Penaeus carinatus</i> , Dana	..	X	..	..	1'000—1'0265	X	X	Karachi to Japan.	X
" <i>indicus</i> , Milne-Edwards	..	X	..	..	1'000—1'0265	X	X	Red Sea and E. Africa to China.	X
<i>Penaeopsis monoceros</i> (Fabricius)	..	X	..	..	1'000—1'0265	X	X	Indus delta to Japan; ? Australia.	X
" <i>affinis</i> (Milne-Edwards)	..	X	..	..	1'008—1'011	X	?	Indus delta to Japan.	?
" <i>dobsoni</i> (Miers)	..	X	..	..	1'000—1'0265	X	X	Coasts of India; Makassar.	X
SERGESTIDAE.									
<i>Lucifer hansenii</i> , Nobili	..	X	..	..	1'000—1'0265	X	X	Red Sea; Bay of Bengal.	X

¹ Probably 1'000—1'0265.

locality a small colony of *Dotilla clepsydrodactylus* was found. In the same month, in other parts of the outer channel, a few immature specimens of *Matuta victor* and single examples of *Dotilla myctiroides*, *Sesarma tetragonum*, *Plagusia depressa tuberculata*, *Leander styliferus* and *Leptochela aculeocaudata* were obtained. Although special efforts were made, these species were not to be found later in the year when the water was fresh and, from the evidence we are able to offer, it appears that they are merely visitors, either brought by chance into the position in which they were found, or seeking shelter from the breakers on the coast-line in the still waters at the mouth of the lake. They are unable to withstand the great alterations in salinity to which the outer channel is subject and in the flood-season must either retire to the sea or perish.

There is evidence that the two species of the almost terrestrial genus *Coenobita*, found in the outer channel, had migrated from the sea-shore, for some of our specimens were inhabiting marine shells not found in a living condition in the lake. The great majority of the specimens were very small and no ovigerous females were obtained. We regard these species also as casual visitors.

The great majority of the casual visitors from the sea are species of wide Indo-pacific distribution.

Palaemon scabriculus, of which two specimens were obtained in brackish water at the mouth of a small stream running into Rambha Bay, is apparently a casual visitor from fresh water.¹

Although our knowledge of other bodies of water of low or variable salinity on the Indian coast is still meagre, it is possible to institute some comparison between the Decapod fauna of the Chilka Lake and that of the Gangetic delta and of the backwaters near Madras.

The following species, permanent inhabitants of the Chilka Lake, are also known from brackish water in the Gangetic delta, to the Crustacea of which the late Mr. J. Wood-Mason and Col. Alcock devoted much attention:—

<i>Pachygrapsus propinquus.</i>	<i>Clibanarius padavensis.</i>
<i>Varuna litterata.</i>	<i>Penaeus carinatus.</i>
<i>Scylla serrata.</i>	<i>Penaeus indicus.</i>
<i>Neptunus pelagicus.</i>	<i>Penaeopsis monoceros.</i>

Metaplex and *Hymenicus*, genera which are plentiful in the Gangetic delta, do not occur in the lake.

A far larger number of species are common to the Chilka Lake and to the backwaters near Madras. Our knowledge of the Decapod fauna of the latter is due to the researches of Dr. J. R. Henderson and to the collections recently made by Dr. Annandale at Ennur:—

¹ A Potamonid crab, *Paratelphusa* (*Oziotelphusa*) *hydrodromus* (Herbst), is common in rice-fields, streams and artificial ponds in the surrounding country. Though we have never found it in the lake itself, it may occasionally wander there in the flood-season.

<i>Ebalia malefactorix.</i>	<i>Scylla serrata.</i>
<i>Ocyropa macrocera.</i>	<i>Clibanarius padavensis.</i>
<i>Gelasimus annulipes.</i>	<i>Clibanarius longitarsis.</i>
<i>Pachygrapsus propinquus.</i>	<i>Clibanarius olivaceus.</i>
<i>Varuna litterata.</i>	<i>Diogenes avarus.</i>
<i>Camptandrium sexdentatum.</i>	<i>Urocaris indica.</i>
<i>Sesarma batavicum.</i>	<i>Periclimenes demani.</i>
<i>Cardiosoma carnifex.</i>	<i>Ogyrides striaticauda.</i>
<i>Heteropanope indica.</i>	<i>Alpheus malabaricus.</i>
<i>Leipocten sordidulum.</i>	<i>Penaeus carinatus.</i>
	<i>Penaeopsis dobsoni.</i>

Metasesarma rousseauxi, *Sesarma quadratum* and *Neptunus sanguinolentus*, common and characteristic species in the Madras backwaters, are absent from the Chilka Lake.

It is noteworthy that a considerable number of the species in the above list are known only from Indian backwaters, whereas the majority of those common to the Chilka Lake and the Gangetic delta are widely distributed forms. *Ebalia malefactorix* and *Ogyrides striaticauda* have also been found in the Cochin backwaters on the south-west coast of India.

As far as the Decapods are concerned, therefore, the lake fauna shows a much greater resemblance to that of the Madras backwaters than to that of the Gangetic delta, and this fact is also illustrated by other groups of animals.

Owing to the fact that our survey of the lake fauna was, in the main, restricted to one year, our observations on the periods at which the different species breed are unfortunately very incomplete; but in a few instances the evidence is interesting. On the Indian coasts in February and March females of the great majority of littoral marine Decapoda are to be found bearing eggs and, inasmuch as the water of the lake is at this period almost at its maximum salinity, it would naturally be supposed that species usually marine, or closely related to marine forms, would breed at this season. In several instances, however, this is certainly not the case.

Only of five species (all of them forms found in the outer channel, but absent from the main area) were ovigerous females obtained solely in water as salt as that of the Bay of Bengal (sp. gr. 1.0265). These are:—

<i>Dotilla pertinax.</i>	<i>Ogyrides striaticauda.</i>
<i>Diogenes avarus.</i>	<i>Athanas dimorphus.</i>
	<i>Alpheus malabaricus.</i>

As far as our observations go, seven species breed in water that is strongly saline or brackish, but were not found bearing eggs in fresh water. The names of these species are as follows, the specific gravities of the water in which ovigerous females were found being added in brackets:—

Pachygrapsus propinquus (1·0075—1·00975). *Upogebia heterocheir* (1·001—1·0125).
Heteropanope indica (1·012—1·0265). *Clibanarius padavensis* (1·010—1·0265).
Leipocten sordidulum (1·0125). *Palaemon lamarrei* (1·007—1·011).
 Urocaris indica (1·006—1·0265).

Two species were found bearing eggs both in fresh water and in water as salt as the Bay of Bengal in the vicinity of the lake (sp. gr. 1·000—1·0265):—

Periclimenes demani.

Alpheus crassimanus.

Four species appear to breed only in water that is fresh or of low salinity:—

Ebalia malefactorix (1·000—1·011). *Caridina nilotica* (1·000—1·015).

Philyra alcocki (1·000—1·011). *Caridina propinqua* (1·000—1·015).

As has already been remarked, *Palaemon malcolmsoni* and *P. rudis* breed exclusively in fresh water and this is perhaps also true of *Elamena cimex*.

In some species, such as *Urocaris indica*, *Periclimenes demani* and *Alpheus crassimanus*, there are perhaps two distinct breeding seasons, but our observations are not sufficiently numerous for us to be certain that this is the case. The two species of *Caridina* breed in the lake throughout the year, reproduction being, however, inhibited when they are brought in contact with water of high salinity.

Owing to the fact that Penaeids do not carry their eggs attached to the swimmerets, as is the case with other Decapoda, it is more difficult to determine the periods at which reproduction takes place. Several circumstances, however, which will be explained in detail hereafter, point to the conclusion that none of the species of *Penaeus* or *Penaeopsis* breed in the lake. Prawns of these genera apparently enter from the sea at the close of the post-larval stages and return thereto when they are sexually mature. In the case of *Penaeopsis dobsoni* there is evidence which tends to show that the females, having once bred, do not again re-enter the lake.

The fifty-four species of Decapoda found in the Chilka Lake comprise thirty-eight genera. The Paguridea of the lake have been determined by Dr. J. R. Henderson, Superintendent of the Madras Museum, who has published a short paper on the subject in the Records of the Indian Museum, describing as new, one species, *Clibanarius olivaceus*. Of the remaining Decapoda thirteen species and one genus do not appear to have been recognized before, while six other forms are recorded for the first time from Indian waters. With three of the undescribed species I have associated the names of Col. A. Alcock, Dr. J. R. Henderson, and Dr. J. G. de Man, to whom more than to any others we are indebted for our knowledge of the Decapod fauna of India. The species of *Callianassa* is identified with a form hitherto known only from a single claw found in a sub-fossil condition in Siam. *Athanas polymorphus*, sp. nov., is of particular interest in the existence among the males of a well-marked trimorphism.

A complete set of all the species, including the types of those hitherto unknown, is preserved in the collection of the Indian Museum.

The methods employed in the capture of the specimens are detailed in the Introduction to this volume (p. 16); an account of the traps used by the Uriya fishermen will be published later.

Our observations on the salinity of the water are expressed in the form of specific gravities. The instrument employed was calibrated for 15°C., and to this temperature all readings have been reduced.

DECAPODA REPTANTIA

Tribe OXYSTOMATA.

Family CALAPPIDAE.

Genus MATUTA, Fabricius.

Matuta victor, Fabr., Hilgendorf.

1896. *Matuta victor*, Alcock, *Journ. Asiat. Soc. Bengal*, LXV, p. 160.

Six small specimens that appear to belong to this species were found in March 1914, in the outer channel; the carapace of the largest is only 11.5 mm. in length. At the time when they were obtained the water in this part of the lake was as salt as that of the Sea in the vicinity; none were found during September when the outer channel is filled with water which is quite fresh.

The species, which is one of very wide Indo-pacific distribution, is evidently carried into the outer parts of the lake during the inflow of salt water; it should be regarded merely as a visitor to the lake-system and not as a permanent inhabitant.

Family LEUCOSIIDAE.

Genus EBALIA, Leach.

Ebalia malefactorix, sp. nov.

(Plate XII, fig. 1.)

The carapace is polygonal in outline and as broad as, or a little broader than long (plate xii, fig. 1.) The postero-lateral borders are very long and gradually convergent posteriorly and the entire margin is elegantly beaded. The side-walls of the hepatic region form a large independent antero-lateral facet on either side of the carapace, extending beneath the eyes to the base of the antennules. The margin that defines the lower limit of this facet is beaded like the true antero-lateral margin and, in dorsal view, is visible in almost its entire extent; a little behind the middle of its length it protrudes slightly in the form of a large obtusely rounded angle.

The front is finely beaded and nearly straight, with a slight and ill-defined median emargination; in dorsal view the edge of the buccal cavern is visible. The antero-lateral margin in large males is obtusely angled in two places and its junction with the postero-lateral margin is very prominent and sharply rectangular. The postero-lateral margin is sharply angulate in its anterior third (this angle marking the termination of a large granular elevation on either side of the carapace) and, in males and some females, one or two of the marginal beads or tubercles in the posterior third

are enlarged, again breaking the evenness of the contour. The posterior margin is convex in the female; in large males it is tridentate owing to the enlargement of the tubercles in the centre and at the outer angles. The infero-lateral margin of the carapace is defined by a beaded ridge immediately above the bases of the legs and this beading extends posteriorly from side to side across the carapace close to the insertion of the first abdominal somite. There are thus, at the posterior end of the carapace, two transverse rows of beading, the uppermost, which is the continuation of the postero-lateral margins, being tridentate in the male.

The most conspicuous feature of the dorsal surface of the carapace is a prominent ridge, much elevated above the general surface and covered with large close-set tubercles, which roughly takes the form of a "broad-arrow" with the point directed forwards. The point is formed by a tuberculate eminence situated in the median line of the carapace a little in front of its middle point. The haft of the arrow extends directly backwards in the mid-dorsal line and ends on the intestinal region before reaching the posterior margin; the wings reach obliquely outwards and backwards on the branchial region and terminate in a sharp prominence in the anterior third of the postero-lateral margin. The tuberculate elevations on the branchial and intestinal regions are separated by narrow grooves from the central cardiac area.

There is usually a short row of large tubercles extending forwards from the cardiac region on either side of the gastric area, continued with or without a brief interruption as a narrow row of smaller tubercles which reaches the front near the inner limit of each orbit, a short branch diverging on the outer side to the back of the orbit itself. There is also a cluster of large tubercles, more conspicuous in the male than in the female, in the vicinity of the first angulation on the antero-lateral margin of the carapace and short row of four or five large tubercles extending transversely outwards on either side from the granular patch on the intestinal region. The areas between the granular patches are sunken and quite smooth; among the granules themselves a few sparse hairs are to be found.

In females, especially in young individuals, the tuberculation of the carapace is much stronger than in males (*cf.* text-fig. 1a and pl. xii, fig. 1).

The eyes are small and the cornea is exposed in dorsal view; the orbit is in open communication with the antennular fossae and there is a well-marked space between the edge of the floor of the orbit and the free edge of the buccal cavern. The antennae are small but distinct.

The buccal cavern is a little broader than long. In the external maxillipedes the merus, which is pointed distally, is nearly as long as the ischium and the exopod does not reach so far as the merus of the endopod and is expanded with a convex external margin.

The chelipedes are slightly longer than the carapace in the male, slightly shorter in the female. The merus is more or less cylindrical, covered with vesiculous granules beneath and, dorsally, with granules arranged in parallel rows, a median longitudinal area being left quite naked. The outer edges of the carpus and propodus are very finely granulate and numerous scattered granules are to be seen on the

upper and inner surfaces of the carpus and palm. The palm is scarcely one quarter longer than broad and is not longer than the fingers; near its proximal end on the inner surface there is, in the adult male, a large coarse tubercle. The dactylus of the last pair of walking legs is considerably longer than the propodus.

The margin of the thoracic sternum is festooned with small granules, which also invest the basal parts of the abdomen in both sexes. The abdomen of the male (text-fig. 1b) consists of two pieces only, the penultimate portion bearing a large blunt tubercle at its distal end. The fused segments of the female abdomen are coarsely punctured and in the middle line near the distal end there is a small granular patch; the ultimate segment is about as broad as long (text-fig. 1c).

Living specimens were, as a rule, rather thickly coated with fine mud. When this was removed they were found to be dull grey in colour, flecked with darker grey, the walking legs and the tubercular elevations of the carapace being reddish-brown.

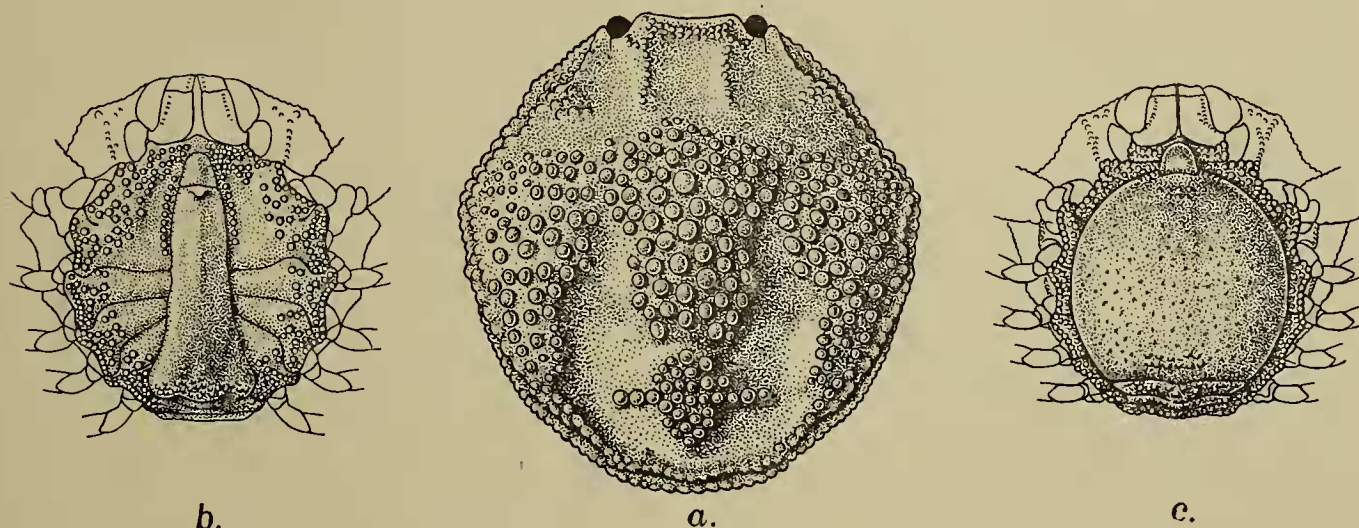


FIG. 1.—*Ebalia malefactorix*, sp. nov.

- a. Carapace of young female with unusually strong tuberculation.
- b. Carapace of male in ventral view.
- c. Carapace of female in ventral view.

The largest specimen in the collection is a male, 10.4 mm. in length. The majority of adult examples are from 7 to 9 mm. in length; but one female, only 4.3 mm. long, is fully adult and bears eggs. The smallest individual, about 2 mm. in length, differs in no respect from adults except that the ridges on the carapace are rather more strongly pronounced and the marginal angulations a little sharper.

Ebalia malefactorix appears to be closely related to *E. sagittifera*¹, Alcock, and *E. hypsilon* (Ortmann)². *E. sagittifera*, from Karachi, the types of which I have examined, is a much smaller form and differs in many respects from the Chilka Lake

¹ *E. sagittifera*, Alcock, *Journ. Asiat. Soc. Bengal*, LXV, p. 188 (1896) and *Ill. Zool. 'Investigator'*, *Crust.*, pl. xxix, fig. 9.

² *Nursia ypsilon*, Ortmann, in *Semon's Zool. Forschungsreisen Austral. u. Malay Arch.*, *Crust.*, V, p. 36, pl. ii, fig. 7.

species; thus, (i) the margin of the front and orbits is not beaded, (ii) the granular ridges on the carapace, though arrow-shaped, are less strongly elevated and are covered only with minute granules and the other tubercular ridges found in *E. malefactorix* are absent, (iii) the posterior margin bears two tubercles in the female and three large petaloid processes in the male, (iv) the chelipedes and walking-legs are decidedly longer than in the allied species and the fingers in the male are only two-thirds the length of the palm, (v) the apex of the merus of the outer maxillipedes is deeply notched, and (vi) the penultimate segment of the abdomen of the male does not bear a tubercle.

Ebalia hypsilon, found at Thursday I., is perhaps even more closely allied; but in this species, according to Ortmann's figure and description, the ribs on the carapace do not form a connected arrow-shaped ridge. The lateral ribs are Y-shaped and are widely separated from the raised area on the cardiac region which bears three isolated rows of large tubercles. There is a disconnected rounded patch of tubercles on the intestinal region and those found on the anterior part of the carapace in *E. malefactorix* are apparently absent. Moreover the entire upper surface of the carapace bears fine scattered granulations and the pterygostomian ridge is not angulate in the middle.

This species, which was found on twenty-seven occasions, is by no means uncommon in the Chilka Lake. In the main area it does not occur in great abundance, but has been found from Rambha in the south to Nalbano in the north, at depths ranging from a few inches to $8\frac{1}{2}$ ft. In the outer channel it occurs on muddy ground near Satpara and Barhampur I., but is not found on the sandy bottom nearer the mouth of the lake.

Ebalia malefactorix seems to prefer water of low salinity. At the period when the outer channel was at its saltiest (in March) it was scarce, but in the same locality in September, when the water was quite fresh, it occurred in abundance. Ovigerous females were caught in the months of March, September and October in water of specific gravity varying from 1.000 to 1.011.

Specimens of this species were found by Mr. Gravely in September 1914, in the backwaters of Cochin, near Ernakulam, and others were obtained by Dr. Annandale in January 1915, in the backwater at Ennur, near Madras (sp. gr. 1.0025). Ovigerous females were caught on both occasions.

The type specimens are registered in the books of the Indian Museum under no. 8941/10.

Genus **PHILYRA**, Leach.

Philyra alcocki, sp. nov.

(Plate XII, fig. 2.)

The carapace is suborbicular and longer than broad in the proportion of 12 to 11. The whole upper surface is microscopically granulate and is covered with rather coarse and distant pits (pl. xii, fig. 2).

The front is somewhat produced, more so than is customary in the genus, and is

narrow ; the breadth of the fronto-orbital border is contained about four and one-third times in the maximum breadth of the carapace. The frontal margin is straight, not furrowed, with a single large, median tooth which projects over the otherwise visible margin of the endostome. The dorsal surface of the front is coarsely pitted. The orbit is very small, with distinct dorsal and lateral fissures, and beneath the eye there is a small notch in the margin of the endostome. The orbit is in open communication with the antennular fossae and there is no space between the floor of the orbit and the edge of the buccal cavern.

The side walls of the hepatic region form an independent facet, bounded below by a finely beaded ridge, which is strongly convex inferiorly. This ridge ends in front close beneath the antero-lateral margin at the outer limit of the orbit; posteriorly it joins the antero-lateral margin in a well-marked though obtuse angle. A small prominence defines the junction of the antero- and postero-lateral margins and behind this one or two small projections, the terminations of dorsal rows of tubercles, are visible. The posterior margin is short, straight in the female and concave in the male ; the outer angles are strongly marked in the former sex, while in adult males they take the form of two large blunt teeth.

On the upper surface of the carapace the cardio-gastric is separated on either side from the branchial region by a shallow depression and the surface is still further broken by the presence of blunt tubercles which form a definite pattern among the fine granules with which the entire surface is covered. The tubercles are most strongly developed in the adult male, but can readily be seen with the naked eye in both sexes when the surface moisture has been removed. There is, in the first place, a somewhat ill-defined patch of tubercles on the intestinal elevation. In front of this, and not distinctly separated from it, is another similar patch on the cardiac region, which is continued forwards to the gastric region as three ill-defined and widely separated rows of tubercles, the lateral being obsolete in the female. In some specimens the median row is continued as a very fine mid-dorsal carina up to the front.

The tubercles on the branchial region are, as a rule, more distinct than the rest. On either side of the carapace, midway between the middle line and the lateral margin, is a sinuous row of tubercles which curves outwards posteriorly and terminates in the middle of the postero-lateral margin, the junction being often defined by a slight prominence. In front of this row and parallel to its posterior portion is another row of tubercles (less conspicuous in the female) which joins it near its anterior end and is directed obliquely backwards and outwards culminating in a distinct prominence in the anterior third of the postero-lateral margin. This row of tubercles occupies much the same position as the two ridges in *P. olivacea*, Rathbun. Seen in lateral view the figure formed by the tubercles resembles a cursive n.

In the third maxillipedes the length of the merus measured along its inner border is little less than that of the ischium. The flagellum is greatly expanded ; its outer edge is strongly convex and the anterior end broadly rounded. The buccal cavern is decidedly broader than long.

The chelipedes in the adult male are one and a half times the length of the carapace, a little shorter in females and young males—about one and a third times. Except for the under surface of the chela the entire chelipede is covered with minute close-set granules similar to those on the carapace. The upper surface of the merus bears three rather obscure rows of small tubercles and the granules on the outer margin of the palm are rather larger than elsewhere. The palm is about one and three quarter times as long as broad; the fingers are about as long as the palm and are grooved and provided with small teeth; when closed, a small proximal gap remains between them. The dactylus of the last leg is about one and a half times as long as the propodus.

In the male the marginal portions of the sternum are finely granulate and deeply pitted. There is a huge longitudinal ridge, abruptly declivous posteriorly, at the base of each chelipede and, in fully adult individuals, there is a very large tubercle on either side of the abdomen opposite the bases of the first walking legs (text-fig. 2).

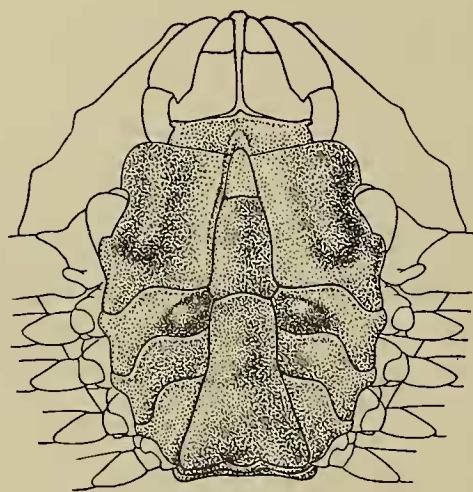


FIG. 2.—*Philyra alcocki*, sp. nov.
Carapace of large male, ventral view.

The abdomen of the male consists of three movable pieces and is not granulate. The first segment is acutely produced on either side and, though it appears distinct, is in reality fused to the succeeding piece. The penultimate portion is about one and a third times as long as broad; at its base it is sharply angulate on either side and broader than the distal end of the preceding piece. The ultimate segment is a little less than twice as long as broad. The abdomen of the female is very coarsely and deeply pitted, the ultimate segment being a trifle longer than broad.

The largest specimen, a female, is 13.5 mm. in length. It is only in males measuring 12.5 mm.

and upwards that the characteristic sternal tubercles are developed.

In its produced and narrow front, provided with a median tooth that projects beyond the endostome, *P. alcocki* resembles *Pseudophilyra* rather than *Philyra*; but it agrees with the latter genus in the shape of the buccal cavern and of the outer maxillipedes. Laurie, in discussing the characters of *P. adamsi*¹ has already commented on the features in which certain species of *Philyra* resemble *Pseudophilyra*; there is little doubt that the present species, along with that which Laurie examined, may correctly be referred to the *platycheira* section of the former genus.

Philyra alcocki seems to find its nearest ally in *P. olivacea*, Rathbun², a species described from Lem Ngob in the Gulf of Siam, but differs from that form in numerous details. In *P. alcocki*, for instance, (i) the carapace is noticeably broader in proportion to its length; (ii) its surface is not so conspicuously granulate; (iii) the rows of

¹ Laurie, *Rep. Pearl Oyster Fisheries, Ceylon*, V, p. 364 (1906).

² Rathbun, *Proc. Biol. Soc. Washington*, XXII, p. 108 (1909) and *Danske Vidensk. Selsk. Skrifter* (7), *Naturvid. og math.*, V, p. 312, pl. ii, fig. 17, text-fig. 4 (1910).

granules on either side of the carapace are differently disposed (they form a Λ -shaped figure in *P. olivacea*) and there are distinct angulations at the points when these rows meet the postero-lateral borders; (iv) the posterior margin is bilobate in the adult male (trilobate in *P. olivacea*); (v) there are two pairs of large tubercles on the sternum of the adult male and the margin bordering the anterior part of the abdominal cavity is not granulate; (vi) the palm of the chelae is proportionately more slender and is as long as the fingers; (vii) in the abdomen of the male the penultimate piece is broadest distally, and is at this point sharply angulate on either side.

It also bears some resemblance to *P. sexangula*, Alcock¹, recorded from the Godavari coast and the Persian Gulf and also obtained a few years ago by Dr. J. T. Jenkins in the Matlah river in the Gangetic delta. *P. alcocki* differs, however, from this species in many notable points, (i) in the narrower front and general shape of the carapace, (ii) in the presence of a Λ -shaped pattern of tubercles on either side of the carapace in place of a single oblique ridge, (iii) in the much shorter chelipedes and in the absence of a granular ridge on the upper surface of the palm, and (iv) in the abdomen of the male, which is composed of three instead of two pieces.

From *P. fuliginosa*, Targioni Tozzetti², *P. alcocki* is more obviously distinct, differing in its much broader form, in the different arrangement of the granules on the carapace, in the proportions of the chela and in the shape of the abdomen of the male.

In life the colour of the carapace was very pale french grey, with fine speckles of dull purplish-red, aggregated to form irregular sinuous markings. The ventral surface was whitish and the legs a very pale brown.

When caught, specimens adopt a cataleptic attitude, folding their legs and holding them with the ischial and meral segments directed vertically downwards from the carapace (text-figs. 3a, b). The *Ebalia*, on the other hand, though they kept quite still and also appeared to be simulating death, held their legs normally, with the meral segments tucked up against the carapace.

Philyra alcocki was sometimes found in company with *Ebalia malefactorix*, but appeared to be much less common. It is represented in the collection by sixteen specimens obtained over an area ranging from Rambha in the south to Barkul and Nalbano in the north on a bottom of mud or muddy sand and at depths of from 5 to 10 ft. In September it occurred rarely in the outer channel in fresh water.

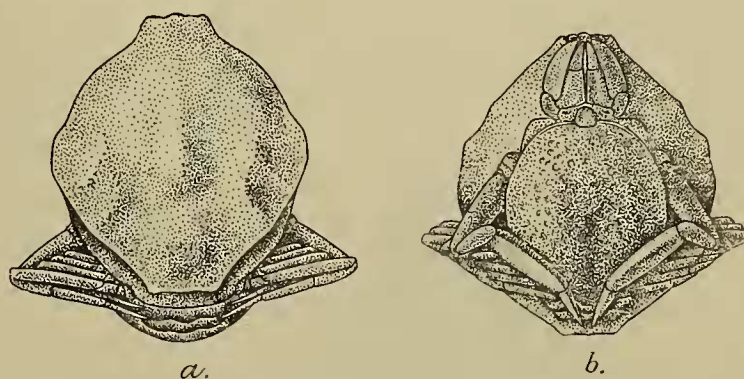


FIG. 3.—*Philyra alcocki*, sp. nov.

A female sketched from life in the attitude which the species adopts when irritated.

a. Dorsal view.

b. Ventral view.

¹ Alcock, *Journ. Asiat. Soc. Bengal*, LXV, p. 241, pl. vii, fig. 2 (1896).

² Targioni Tozzetti, *Zool. Viag. R. P. 'Magenta', Crost.*, p. 201, pl. xii, figs. 3, a-g (Florence, 1877).

Two ovigerous females were obtained in the months of March and September in water of specific gravity varying from 1.000—1.011.

The type specimens are registered under no. 8944/10.

Tribe BRACHYGNATHA.

Family HYMENOSOMATIDAE.

Genus **ELAMENA**, Milne-Edwards.

Sub-genus **Trigonoplax**, Milne-Edwards.

1853. *Trigonoplax*, Milne-Edwards, *Ann. Sci. nat. Zool.* (3), XX, p. 224.

1900. *Trigonoplax*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 386.

Elamena (Trigonoplax) cimex, sp. nov.

(Plate XII, fig. 3.)

The carapace is flat and lamellar and more or less cordiform in shape; its length, including the front, is a trifle greater than the breadth, the proportion being as 31 to 28. The postero-lateral borders show a slight emargination at the base of each of the last two pairs of legs and are only about half as long as the antero-lateral. The regions of the carapace are defined by shallow grooves, the margin is not up-turned, devoid of teeth or tubercles, and except for a few sparse hairs, most noticeable on the hepatic region, the surface is bare (pl. xii, fig. 3).

The front is produced to form a distinct rostrum; it is clearly marked off from the general contour of the carapace and, in the angle formed on either side of its base, the eyes along with portions of the eyestalks are visible. Behind the eye there is a blunt tooth. The rostrum is composed of a single flat plate a little longer than broad; its margins are parallel at the base, narrowing anteriorly to a blunt point.

The antennules are closely juxtaposed at the base; the interantennular septum is wholly missing. The epistome is nearly

twice as broad as long. From the anterior angles of the buccal cavern a sharp ridge runs backwards on either side of the carapace to the bases of the walking legs and the surface between this ridge and the true lateral margin of the carapace behind the eye is deeply concave. The external maxillipedes completely close the buccal cavern. The ischium is a trifle longer than the merus and the exopod, though slightly overlapped at the distal end by the adjacent

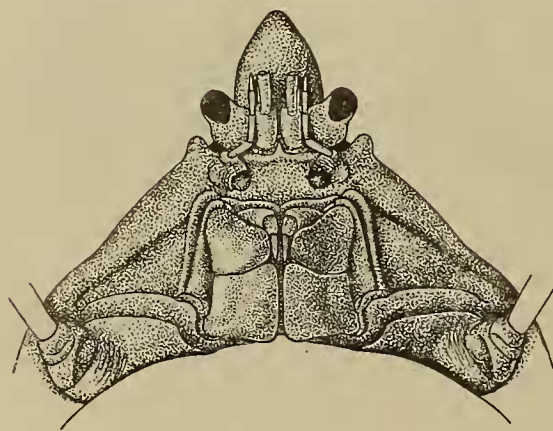


FIG. 4.—*Elamena (Trigonoplax) cimex*, sp. nov.
Anterior part of carapace of a female, seen from below.

margin of the merus, is nevertheless visible, in part, throughout its length (text-fig. 4).

Unfortunately no adult males were obtained. In females and young males the chelipedes are slender and, as consideration of the other characters of the species indicate that it belongs to the sub-genus *Trigonoplax* rather than to *Elamena*, s.s., it may be surmised that they are also slender in the adult male.

In ovigerous females the chelipedes are about as long as the carapace, not stouter and a great deal shorter than any of the walking legs. The carpus is about two-thirds the length of the palm; the fingers are as long as the palm and are curved both horizontally and vertically; when closed, they meet only at the tips which are toothed and slightly spooned. In young males the fingers appear to be a little shorter than the palm.

The first and second pairs of walking legs are about equal in length, nearly two and a half times as long as the carapace, while those of the last pair are the shortest, about one and a half times the length of the carapace. There are no teeth or denticles on the upper margin of any of the segments and the dactyli, which are not broader than the propodi, are set with short hairs, among which, at the distal end, is a series of short recurved teeth (text-fig. 5).

The largest specimen, an ovigerous female, is 7.9 mm. in length.

E. (Trigonoplax) cimex, though it agrees with *E. (Trigonoplax) unguiformis*¹, the type and only other known species of the subgenus², in many important respects, differs in several notable points, in some of which it bears a significant resemblance to allied genera.

The chief points in which it agrees with typical *Trigonoplax* are (i) the simple—not tridentate—rostrum, (ii) the absence of any teeth or an upturned edge on the margin of the carapace, (iii) the considerable length of the epistome, and (iv) the well-developed external maxillipedes which completely close the buccal cavern.

On the other hand the areolation of the carapace is more distinct than in the other member of the sub-genus; the carapace is proportionately much narrower; there is a distinct post-orbital tooth; the interantennular septum—represented, however, merely by a narrow ridge in *E. (Trigonoplax) unguiformis*—is wholly absent; the exognath of the outer maxillipedes is not entirely hidden.

In some at least of these characters it shows considerable resemblance to

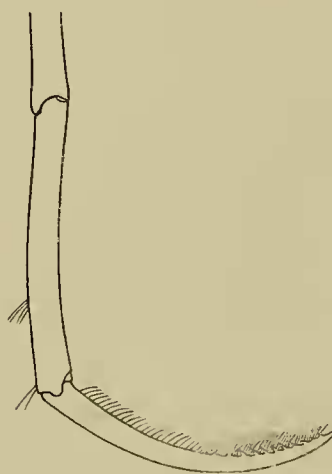


FIG. 5.—*Elamena (Trigonoplax) cimex*, sp. nov.

Propodus and dactylus of last walking leg.

¹ De Haan, in Siebold's *Fauna Japonica*, Crust., p. 75, pl. xxix, fig. 1 (1839); Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 387 (1900); de Man, *Trans. Linn. Soc., Zool.* (2), IX, p. 396 (1907).

² Stimpson's *Trigonoplax truncata* [*Proc. Acad. Nat. Sci. Philadelphia*, X, p. 109 (1858) and *Smithson. Misc. Coll.*, XLIX, p. 146 (1907)] is now regarded as a member of *Elamena*, s.s.

*Rhynchoplax*¹ and to *Hymenicus*², the former of which genera, as Alcock has suggested, is perhaps synonymous with the latter. It differs from both, however, in the simple rostrum and, I believe, also in the slender chelae of the male.³ In addition, it is distinguished from *Hymenicus*, and perhaps also from *Rhynchoplax*, by the well-developed outer maxillipedes which completely occlude the buccal cavern.

In addition to the points mentioned above, *E. (Trigonoplax) cimex* differs from *E. (T.) unguiformis* in its narrower form, in the proportionately shorter antero-lateral borders of the carapace, in the shorter legs and in the dactyli, which are slender (not spatulate) and armed with a greater number of spines.

The colouring of living specimens of *E. (Trigonoplax) cimex* is rather striking. The carapace of an adult female was of a warm reddish-brown tone, tinged with green posteriorly and with a Y-shaped mark of deep umber brown, incompletely circumscribed by cream, extending forwards and inwards on either side from the middle of the lateral margin. The palm of the chelipedes and the distal half of the propodus of all the walking legs was very dark brown, nearly black. The remaining parts of the legs were pale sienna brown.

The carapace, when the animal is walking, is held almost vertically.

The species is represented in our collection by eight specimens, of which, however, only two, which are ovigerous females, are of large size. All were obtained during September 1914, in the outer channel of the lake, chiefly on the weedy and muddy ground in the vicinity of Barhampur I. At the time they were taken the water was quite fresh, but I have no doubt that they are also to be found in the same locality at other times of the year when the water is as salt as that of the Bay of Bengal. The species appeared to be very scarce and it was only with considerable difficulty that specimens could be detected among the weed brought up by the nets.

The type specimens are registered under nos. 8947-8/10.

Family OCYPODIDAE.

Subfamily OCYPODINAE.

Genus OCYPODA, Fabricius.

Two species of this genus, *Ocypoda macrocera*, Milne-Edwards, and *O. platytarsis*, Milne-Edwards, are found living in the sand at the edge of the outer channel of the Chilka Lake at all seasons of the year. They appear to be equally abundant in this situation both when the water in the channel is fresh and when it is salt.

O. cordimana, Desmarest, a species which has not been found in the lake-system, is common on the seaward side of the sand-hills and may at times wander to the shores of the outer channel.

¹ *Rhynchoplax*, Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, X, p. 109 [55] (1858) and *Smithson. Misc. Coll.*, XLIX, p. 147 (1907).

² *Hymenicus*, Dana, *Amer. Journ. Sci.* (2), XII, p. 290 (1851) and *U. S. Explor. Exped., Crust.*, I, p. 387 (1852), redefined by Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 387 (1900).

³ As has already been pointed out, no fully adult males were obtained.

Ocypoda macrocera, H. Milne-Edwards.

1900. *Ocypoda macrocera*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 347.

The colouration of adults of this species is very striking. The carapace is of a faint reddish-chestnut colour, greyer in patches and towards the margins, and the cardiac region is defined anteriorly by a semicircular red-brown line. The outer maxillipedes and adjacent portions of the carapace are stained with deep crimson, the sternum being tinged with crimson, dull purple, reddish-yellow and white. The chelipedes are red at the base with red spines and the outer surface of the large claw is bright orange yellow, paler distally. The walking legs are french grey, reddish beneath, with the tips of the claws yellowish. The eyes are greyish-white, with the ocular horn a deep crimson. In immature specimens, about 20 mm. in breadth, there is no trace of red colouration, the carapace being of a dull creamish tint, heavily marbled with dark grey.

For the following interesting notes on the habits of *O. macrocera* in its early stages I am indebted to Dr. Annandale :—

“The young of this species, both in a late megalopa stage and with their skins still soft after the final metamorphosis, were common on the sandy beach of the Ennur backwater, near Madras, in January 1915. They lay in short and imperfectly formed burrows under logs (catamarans), drawn up just above the water-line where the sand was still damp. The megalopae were sluggish and somewhat helpless, but could run along the sand with fair rapidity, their abdomens tucked away beneath the carapace like those of adult crabs. They were easily knocked over, not being at all well-balanced and, when handled or molested in any way, lay still with their legs and tail all pressed together and “shammed dead.” Their excavating powers were limited. When one was placed in a dish of wet sand, it turned round and round like a dog, moving its limbs in an unco-ordinated manner, until it had found a small hole in which it remained quiescent. The megalopae were not seen coming out of the water, but there is little doubt that they did so at night, for all those found on the shore were approximately the same size (almost the same as that of the fully formed young crabs), and older members of the same species were observed on several occasions, in the early morning, running towards their burrows with young megalopae in their claws. The larvae exhibited considerable power of colour-change, becoming much paler than usual when submitted to a strong light. Their dorsal surface, when they were in their holes, was of an almost uniform dark leaden grey; when they were placed in a glass vessel it became of a pale glaucous shade.”

“The period of the metamorphosis was evidently one of great danger and numerous individuals were observed that had died, both before and after the ecdysis, without apparent injury, probably owing to exhaustion. Allusion has already been made to the cannibal habits of the older crabs of the species, which evidently capture the megalopae and carry them away to be leisurely devoured in their burrows. That they were not merely carrying their young relatives to a place of safety was proved by the fact that one crab was captured carrying the already half-devoured corpse of a megalopa, although in other cases the captives were still uninjured.”

"Under the catamarans on the shore a Doryline ant had constructed galleries in the wet sand. These galleries in several cases were noticed to lead to the burrow of a megalopa or newly perfected crab. In such cases the ants were devouring, or had already devoured, the rightful owner, but whether they had waited till its death before doing so, or had attacked it and eaten it alive, could not be ascertained."

"Full-grown crabs of this species are much more retiring in their habits than young and half-grown individuals, which, at any rate in dull weather, may be seen running about the shore, and even in the neighbouring Casuarina woods at all times of the day. The pellets of sand produced in excavating the burrows were merely shovelled out of the holes in a fan-shaped mass and no effort seemed to be made, at any stage in the life-history, to arrange them neatly. In this respect the holes offered a striking contrast to those of *Dotilla intermedia* on the same beach."

The megalopa and first post-larval stage are figured in text-figs. 6a and 6b from material obtained by Dr. Annandale at Ennur. The megalopa is remarkable for the

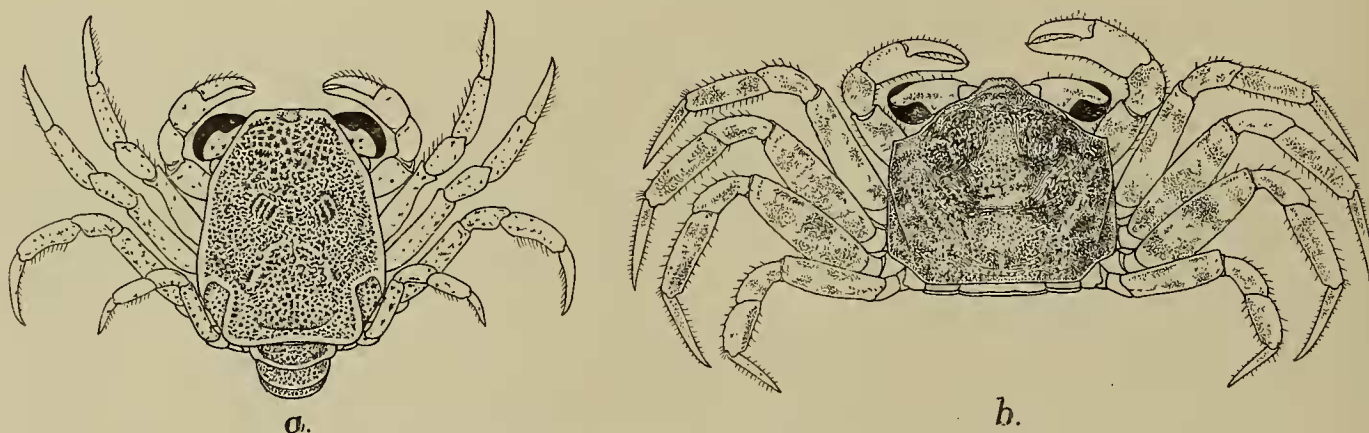


FIG. 6.—*Ocypoda macrocera*, Milne-Edwards.
a. Last megalopa stage. b. First post-larval stage.

presence of deep cavities at the postero-lateral angles of the carapace, into which the last pair of the legs can be folded.

Ocypoda macrocera is common on the sandy shores which fringe the outer channel of the Chilka Lake and also occurs on the adjacent islands. It extends from the mouth of the lake up to Satpara and is found throughout the year, both when the water in the channel is fresh and when it is salt. We failed to find specimens on the neighbouring shores of the Bay of Bengal; but I have little doubt that it occurs there. In the largest specimen obtained, a female, the breadth of the carapace is 32 mm.

The species is known only from the Bay of Bengal and the Gulf of Siam.

Ocypoda platytarsis, H. Milne-Edwards.

1900. *Ocypoda platytarsis*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 348.

This species is abundant on the sandy banks of the outer channel near the mouth of the lake. Like *O. macrocera* it is found at all seasons of the year, when the water

is either fresh or salt. It does not, however, extend so far up the channel as the allied species and it has not been found south of Manikpatna. It is common on the adjacent shores of the Bay of Bengal.

The breadth of the carapace in the largest specimen, a male, is 53 mm.

O. platytarsis is known from both coasts of Peninsular India and from Ceylon.

Genus **GELASIMUS**, Latreille.

1897. *Uca* (Leach, not of Latreille), Rathbun, *Proc. Biol. Soc. Washington*, XI, p. 154.

1900. *Gelasimus*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 350.

Gelasimus annulipes, Latreille (M.-Edw.)

1900. *Gelasimus annulipes*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 353.

The numerous specimens agree well with other examples in the Indian Museum determined by Alcock; the form of the hand in the adult male corresponds very closely with the figure given by Milne-Edwards.¹ The examples are, however, very much smaller than those found in other parts of India, for the breadth of the carapace in the largest male does not exceed 12.5 mm.

Nobili² has drawn attention to a difference in the form of the chela in specimens from the eastern and western portions of the Indo-pacific region. To the eastern form he gave the name var. *orientalis*, but subsequently notes³ that that form is identical with *G. perplexus*, M.-Edw.,⁴ a name relegated by Hilgendorf and Alcock to the synonymy of *G. annulipes*. Still later, Miss Rathbun⁵ recognized *G. perplexus* as a distinct species and gave photographic illustrations of it. The specimens she examined were found at Ceram I. and at Makassar in Celebes, many specimens of typical *G. annulipes* being also found at the latter locality. From the last of these records it is evident that the two forms are not, as Nobili supposed, restricted to separate parts of the Indo-pacific region. But, until further evidence is available, the status of *G. perplexus* must remain doubtful. So far as one is able to judge—for Miss Rathbun gives no description—it is only in the tothing of the large claw of the male that the differential characters are to be found, and in this respect the species of *Gelasimus* often show a wide range of variation. It is only by the examination of long series of specimens from different localities that the point can be determined in a satisfactory manner.

A colony of *Gelasimus annulipes* was found to have established itself in March 1914, on one of the islands in the outer channel of the lake close to Manikpatna. The specimens were living on a narrow strip of land between the water's edge and the coarse grass with which the island was covered. We noticed that the larger individuals occupied the (apparently) more eligible situations close to the water line, while

¹ Milne-Edwards, *Ann. Sci. nat. Zool.* (3), XVIII, pl. iv, fig. 15b (1852).

² Nobili, *Boll. Mus. Torino*, XVI, No. 397, p. 13, text-figs. A, B (1901).

³ Nobili, *Ann. Sci. nat. Zool.* (9), IV, p. 312 (1906).

⁴ Milne-Edwards, *Ann. Sci. nat. Zool.* (3), XVIII, p. 150, pl. iv, figs. 18, 18a (1852).

⁵ Rathbun, *Bull. Mus. Comp. Zool., Harvard*, LII, p. 306, pl. i, figs. 1, 2 (1910).

those that were younger were compelled to live higher up, close to and among the roots of the grass. A detailed and most interesting account of the habits of this and other species of *Gelasimus* has lately been published by Pearse¹, who finds reason to dissent from some of Alcock's views² as to the use of the large claw of the male as a means of sexual attraction. In this connection it may be mentioned that large claws of the male, in the rather diminutive specimens found in the Chilka Lake, were for the most part white and showed only the faintest trace of the deep pink colour which characterises well-grown specimens of the species. There was no indication of the bright blue bands which Nobili³ noticed in certain specimens from S. India.

At the period when the specimens were found, the water in the outer channel was as salt as that of the open sea in the vicinity of the lake. In September of the same year, when it was quite fresh, the colony had entirely disappeared, though whether the individuals were killed off by the fresh water or were induced, by reason of it, to migrate to a more favourable spot remains a matter of conjecture. No specimens of the species were found anywhere in the outer channel in September 1914, though a single example was obtained in the same month of the preceding year on the shore at Satpara; the example may possibly have been brought there by the fishing boats, but this seems unlikely.

The evidence available appears, therefore, to point to the fact that the species is unable to withstand the periodical freshwater floods, and to this conclusion the small dimensions of the specimens also lends colour. Certain other species of amphibious Crustacea found in the outer channel (*Ocypoda*, *Dotilla pertinax* and *Cardiosoma*) seem, on the contrary, in no wise affected by the great changes in salinity.

Subfamily SCOPIMERINAE.

Genus DOTILLA, Stimpson.

Dotilla pertinax, sp. nov.

(Plate XII, fig. 4.)

The carapace is broader than long in the proportion of 4 to 3 and is strongly areolated and grooved; the grooves are always smooth, while the areolae are for the most part either tubercular or clothed with short stiff setae.

From the front a deep groove runs backwards and bifurcates almost immediately; its two branches are continued obliquely backwards in a straight line to the postero-lateral angles, gradually decreasing in depth towards their distal extremities. Another groove starts in the anterior third of the carapace from each of the branches and runs transversely outwards to the lateral margin; from each transverse groove a short branch runs forwards to the middle of the orbit. In the posterior two-thirds of the carapace, parallel to the lateral margin is a deep and very conspicuous groove, anteriorly bifurcated and Y-shaped (as in *D. malabarica*, *D. sulcata* and *D. fenestrata*),

¹ Pearse, *Philippine Journ. Sci.*, VII, p. 113 (1912).

² Alcock, *Ann. Mag. Nat. Hist.* (6), X, p. 415 (1892).

³ Nobili, *Boll. Mus. Torino*, XVIII, No. 452, p. 20 (1903).

while another groove, faint but distinct, runs transversely close to the posterior margin (pl. xii, fig. 4).

The central triangular region of the carapace, delimited by the two oblique grooves mentioned above, is rather obscurely divided by shallow depressions into post-gastric and cardio-intestinal areolas. The first of these is bluntly elevated anteriorly and the lateral portions of both bear a few coarse and ill-defined tubercles. There is no median longitudinal groove on the anterior part of the post-gastric region. The elevated portions of the carapace behind the orbit also bear tubercles, while those which surround the Y-shaped lateral grooves are finely granulate and set with coarse, stiff setae.

The orbital margin is sinuous and its outer angle, owing to a deep emargination immediately behind it, is prominent and acute in dorsal view. The trough in which the eye lies is continuous beneath this point with a groove which extends along the upper limit of the side-walls of the carapace. The apex of the front is narrowly

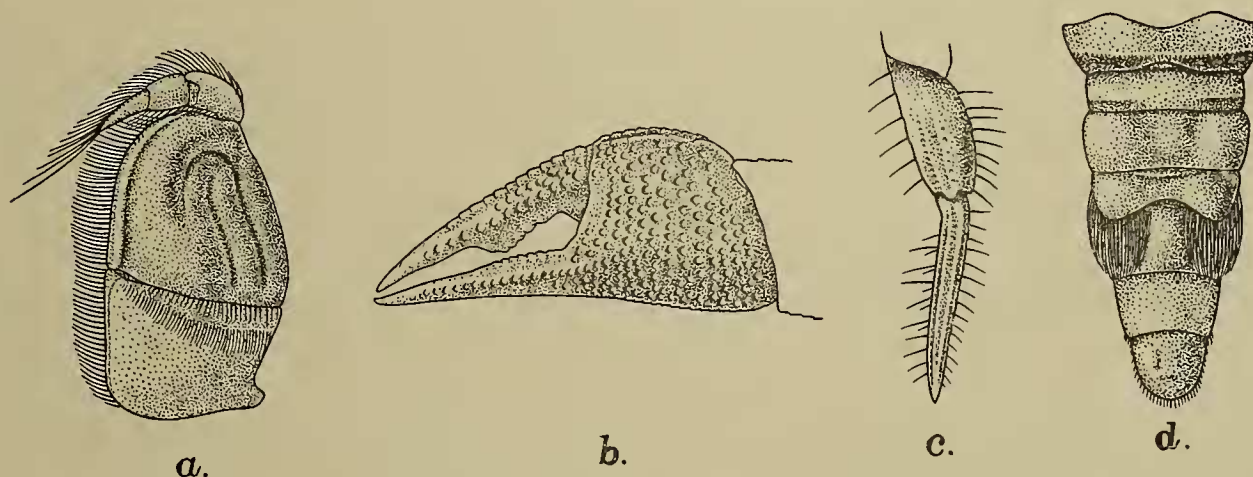


FIG. 7.—*Dotilla pertinax*, sp. nov.

a. Outer maxillipede.

b. Chela of male.

c. Propodus and dactylus of last leg.

d. Abdomen of male.

rounded and the subhepatic and pterygostomian regions are finely granular, set with coarse setae, and show the characteristic convolute sulci.

In the external maxillipedes the merus is very much larger than the ischium and is deeply sulcate as shown in text-fig. 7a; the grooves cover the greater part of the segment and are not restricted to its outer half as in *D. blanfordi*, *D. intermedia* and *D. wichmanni*. The surface is minutely granulate and bears very short stiff setae.

Measured round the curve, the length of the chelipedes in males that appear to be adult is less than twice the length of the carapace. The spine or tubercle found on the under surface of the merus in *D. sulcata* is absent. The outer surface of the carpus and chela is closely covered with large vesiculous granules (text-fig. 7b) which, in some specimens, also invest the inner surface of the palm. On the dorsal edge of the palm the granules are often a little elongated, forming an obscurely defined double ridge; this feature, however, frequently cannot be detected. From the apex of the fixed finger, on its outer side, a granular ridge extends backwards on to the palm,

where it merges with the other granules; the palm is rounded inferiorly and does not bear the fine carinae found in *D. clepsydrodactylus* or *D. malabarica*. The cutting edge of the fixed finger is serrated in its proximal half, but is without teeth. The dactylus, which is about twice the length of the upper border of the palm, bears several rows of granules and its cutting edge, in large males, is produced in the middle to form an angular blade furnished with a few small serrations. When the claw is closed this blade and the extreme tip are the only points in contact with the fixed finger. In females the blade is entirely absent and it is relatively feebly developed in young males.

There is a small "tympanum" on the outer surface of the merus of the chelipedes and a large one on both upper and lower surfaces of this segment in all the walking legs. The merus of the first three walking legs is expanded and the propodus, which is ornamented with longitudinal rows of granules, is scarcely shorter than the dactylus. The dactyli of all the walking legs are conspicuously grooved dorsally, that of the last pair is about one-third longer than the propodus in adults (text-fig. 7c), a little longer proportionately in young specimens.

The sternal plates corresponding to the chelipedes are transversely ridged at their *posterior* end¹, the remainder are smooth except for fine scattered granules. There are no sternal "tympana."

The distal end of the fourth abdominal segment is deeply emarginate and bears the usual tuft of thick bristles overhanging the succeeding segment (text-fig. 7d). The abdomen of the female is closely similar to that of the male; it is scarcely broader and has the same emarginate fourth segment and the same tuft of bristles. It affords no protection to the eggs, which extrude on either side of it like bunches of grapes. The abdomen of fully adult and ovigerous females consists of seven separate segments, thus differing from de Haan's account of *Doto* (= *Dotilla*) *sulcata*².

The carapace of a large male is 5.0 mm. long, 6.4 mm. broad and 4.0 mm. deep. In ovigerous females the breadth of the carapace is only 4.9 mm.

In Alcock's key to the Indian species of *Dotilla*³, *D. pertinax* would take its place alongside *D. clepsydrodactylus*, Alcock, a species which was also found during the survey of the Chilka Lake. From this form it may readily be distinguished by several well-marked characters. In *D. clepsydrodactylus* there is a longitudinal mid-dorsal groove on the carapace and four distinct tubercle-like elevations on the post-gastric region, while the deep groove parallel with the lateral margins is simple and not Y-shaped. There is a large tooth in fully adult males in the middle of the fixed finger and on the lower edge of the chela, which is much more finely granulate externally, there is, even in very small individuals, a well-marked *double* serrated carina. In the legs of the last pair, also, the propodus is much stouter and the dactylus proportionately longer.

¹ Not in the middle as in *D. clepsydrodactylus*.

² De Haan, in Siebold's *Fauna Japonica Crust.*, p. 24 (1833).

³ Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 364.

The configuration of the groove parallel to the lateral margin of the carapace, whether simply linear or Y-shaped, affords a useful character in the discrimination of the species. In this respect *D. pertinax* agrees with *D. malabarica*, Nobili¹; *D. fenestrata*, Hilgendorf²; *D. brevitarsis*, de Man³; *D. sulcata*, Forskål⁴; and *D. affinis*, Alcock⁵; and differs from *D. wichmanni*, de Man⁶; *D. intermedia*, de Man³; *D. clepsydrodactylus*, Alcock⁵; *D. profuga*, Nobili¹ and *D. myctiroides*, Milne-Edwards⁵.

From *D. malabarica* *D. pertinax* is distinguished (i) by the sculpture of the middle portions of the carapace and by the presence of a faint transverse groove close to the posterior margin, (ii) by the presence of a blade-like tooth on the dactylus of the chela in the male, by the greater comparative length of the fingers and by the absence of carinae on the lower surface of the palm, and (iii) by the presence of a large 'tympanum' on the upper side of the merus of the last legs and by the proportionately shorter dactyli.

Hilgendorf's *D. fenestrata* possesses sternal 'tympana', a character which it shares only with *D. myctiroides*, and the features noticed in Alcock's key suffice to distinguish the present form from *D. brevitarsis*, *D. sulcata* and *D. affinis*. Nobili⁷ has drawn attention to the close affinity which exists between the two last named species and, in view of his notes on the variation of *D. sulcata* in the Red Sea, coupled with an examination of specimens of both species (including the types of *D. affinis*) I am inclined to agree with his suggestion that *D. affinis* is merely a synonym of Forskål's *D. sulcata*. In the largest of Alcock's types there is a small tubercle on the lower surface of the merus of the chelipedes in the position which the spine occupies in adult *D. sulcata*.

Living specimens of *Dotilla pertinax* are of a pale sandy brown colour, mottled with black, white, dark brown and orange red. The precise colouring is very variable; there is often a black gastric spot and, in many cases, an orange cardiac blotch. Behind this blotch there is usually a white spot partly surrounded by a brown or black Y-shaped patch, the posterior limb of which extends to the middle of the hinder margin, which is pure white on either side. The furrow at the upper limit of the side walls of the carapace is always deeply pigmented, black, brown or reddish-orange; the sub-hepatic and pterygostomian regions are closely speckled with black and the epistome is often orange red. The legs are banded with brown and white, the carpo-propodal joint of the first two walking legs being orange.

The species constructs burrows in the sand close to the water line; usually the boring is made obliquely and extends to a depth of some six or eight inches. Leading

¹ Nobili, *Boll. Mus. Torino*, XVIII, No. 452, p. 20, fig. 6 (1903).

² Hilgendorf, in van d. Decken's *Reise in Ost-Afrika*, III, p. 85, pl. iii, fig. 5 (1869).

³ De Man, *Journ. Linn. Soc., Zool.*, XXII, pp. 130, 135, pl. ix (1888).

⁴ Nobili, *Ann. Sci. nat. Zool.* (9), IV, p. 315 (1906).

⁵ Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, pp. 363-368 (1900) and *Illust. Zool. 'Investigator'*, *Crust.*, pl. lxiii, figs. 1-3 (1902).

⁶ De Man, in Weber's *Zool. Ergebn. einer Reise in Niederland. Ost-Ind.*, II, p. 308, pl. xviii, fig. 8.

⁷ Nobili, *Boll. Mus. Torino*, XVIII, No. 447, p. 22 (1903).

to the mouth of the burrow there is always a well-constructed avenue or "run," two to four inches in length, formed by smoothing the sand and heaping it up on either side. The pellets brought up from the burrow are cast to one side of this "run" and, as a rule, form a triangular patch visible on the smooth surface at a considerable distance. The crabs seem never to wander beyond the limits of the "run."

D. pertinax occurs commonly on the sandy bars and islands in the outer channel and is abundant, both when the water is fresh and when it is salt; it does not in our experience live within a mile of the actual mouth of the lake. The latter region, during the salt-water season in March 1914, was inhabited by a colony of *D. clepsydrodactylus*. The ovigerous females, of which only two were found, were obtained in March. They accompanied other individuals on the shore.

The type specimens are registered under no. 8937/10.

Dotilla clepsydrodactylus, Alcock.

1900. *Dotilla clepsydrodactylus*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 367; and *Illust. Zool. Investigator*, *Crust.*, pl. lxiii, figs. 2, 2a (1902).

The specimens agree perfectly with the types of the species and with Alcock's account and figures except that the tooth in the middle of the fixed finger is in no case so well developed as is indicated in the original description. Even in individuals in which the carapace is 6 mm. broad, *i.e.* of a size practically identical with that of the largest type specimen, the tooth has merely the form of a low serrated ridge and is only a trifle more prominent than in the preceding species.

In addition to the points mentioned by Alcock it may be noted that the eye is a little flattened and in dorsal view appears almost bilobed, and that there are three finely serrated carinae on the lower surface of the chela, terminating on the fixed finger. Two of these carinae run parallel to one another on the outer aspect of the inferior surface, while the third, situated on the infero-internal border, diverges from them proximally: the lower surface of the palm is in consequence sharply defined, flat and triangular in shape. By the use of this character, coupled with that of the areolation of the carapace (very exactly shown in Alcock's figure) it was easy to distinguish even the smallest specimens of this species from those of *D. pertinax*.

It may ultimately be shown that *D. clepsydrodactylus* is synonymous with *D. intermedia*, de Man, from Sullivan I. in the Mergui Archipelago. I have examined some of the original specimens of the last named species, all of them, unfortunately, small and in rather poor condition. The resemblance to immature *D. clepsydrodactylus* is extremely close, but in the absence of adults from the Mergui Archipelago it is impossible to arrive at any satisfactory conclusion.

Fresh examples of this species were easily distinguished from *D. pertinax* by the absence of the dark speckling on the sub-hepatic and pterygostomian regions.

In March 1914, a colony of *D. clepsydrodactylus* was found to have established itself just inside the mouth of the lake and a stray individual was obtained at the same time in company with *D. pertinax* on the sand-bar opposite Manikpatna. At

this period of the year the water was quite salt. Later, in September, when the water was fresh, no specimens could be discovered.

No species of *Dotilla* were found on the seashore outside the lake. It is not improbable that the violence of the breakers on the coasts of the Bay of Bengal renders such a situation impossible for small and delicate crabs and that they can only flourish in more sheltered spots. *Ocypoda*, perhaps, is able to save itself by its extremely rapid movements.

A number of very small specimens, obtained by Dr. Annandale in the Ennur backwater, near Madras, are also referred to this species. In none of these individuals is there any trace of the large teeth on the fingers of the chelae and the identification is, in consequence, somewhat doubtful.

The type specimens of *D. clepsydrodactylus* were found at False Point on the sea face of the Mahanaddi Delta, a locality less than a hundred miles distant in a direct line from the Chilka Lake. Mr. F. H. Gravely has recently obtained a fine series of the species at Balasore, a little to the north of False Point.

Dotilla myctiroides (Milne-Edwards).

1900. *Dotilla myctiroides*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 368.

A single example of this species, the carapace 6.9 mm. in breadth, was found on the shore of an island in the outer channel near Manikpatna. The specimen was obtained in March 1914, when the water in the channel was salt.

A large ovigerous individual of this species was recently obtained by Dr. Annandale in the Ennur backwater near Madras. The specimen bears an enormous number of eggs, so many that the abdomen projects backwards in a straight line with the carapace, the masses of eggs bulging out on either side of it and of the legs. In this example, precisely as in the ovigerous females of *D. pertinax* mentioned above, the abdomen is quite narrow and in external appearance closely similar to that of the male (*cf.* text-figs. 8a and 8b). It is composed of seven separate segments and it seems probable that this number is found in both sexes of all species of the genus and that de Haan was in error in his statement that in females of *D. sulcata* there are only five.

The supposed scarcity of females in the genus *Dotilla* has often been the subject of comment; but this, I believe, is to be explained by the close similarity in the form of the abdomen in the two sexes. It is, however, curious that ovigerous females are not more abundant; the eggs, which are poorly protected and must be a great encumbrance to the mother, are perhaps only carried for a very short period and it is noteworthy that the ovigerous specimen of *D. myctiroides* from Ennur was

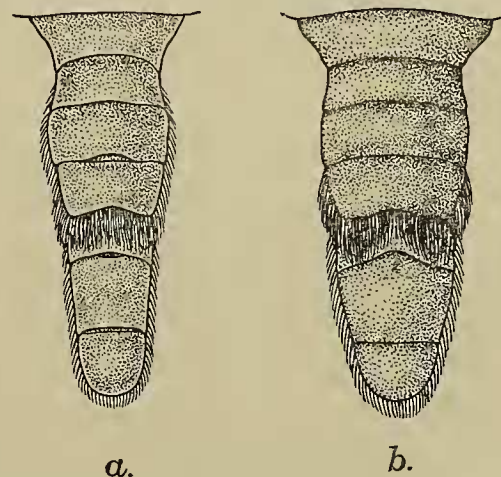


FIG. 8.—*Dotilla myctiroides* (H. Milne-Edwards).

a. Abdomen of male.
b. Abdomen of female.

not taken on the shore, but on the bottom in several feet of water. With the females of *D. pertinax* this was not the case, but it is possible that the eggs in the specimens of this species were freshly extruded.

Subfamily *MACROPHTHALMINAE*.

Genus *MACROPHTHALMUS*, Latreille.

Macrophthalmus gastrodues, sp. nov.

(Plate XII, fig. 5.)

The carapace is sub-quadrate, the greatest breadth being only about 1.2 times the greatest length: it is strongly convex both fore and aft and from side to side. The lateral margins are posteriorly divergent, the point of greatest breadth being near the base of the penultimate legs. The breadth across the orbital angles is very little greater than the length (pl. xii, fig. 5).

The front is obliquely deflexed; though longitudinally grooved above, the

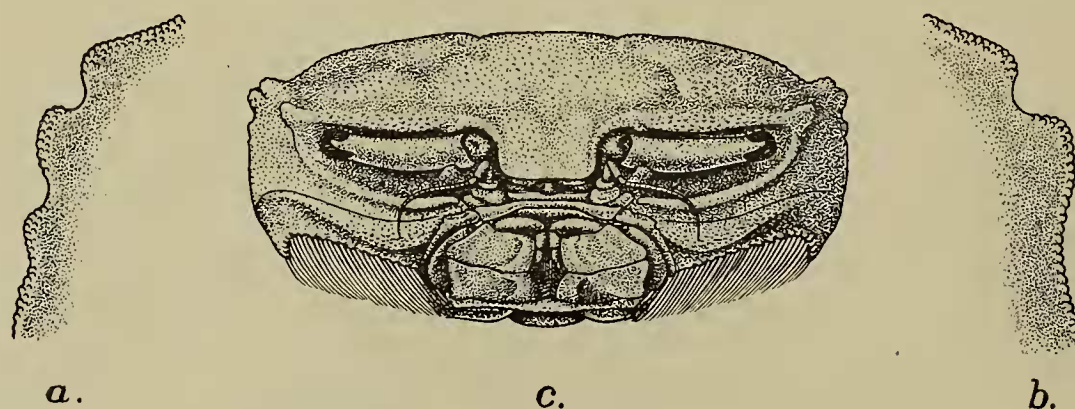


FIG. 9.—*Macrophthalmus gastrodues*, sp. nov.

- a.* Antero-lateral border of carapace of the female specimen, left side.
b. Do. do. do. do. right side.
c. Carapace of the male specimen, viewed from in front.

anterior margin is not bilobed, but is straight or very slightly emarginate in the middle (text-fig. 9c). The breadth of the front is about one-sixth the breadth of the carapace at the outer orbital angles, a little wider proportionately in the male than in the female.

The orbits are markedly oblique and rather strongly sinuous. The outer orbital angle is obtuse in both sexes, a little sharper in the male than in the female. Behind it, in the former sex, are three lobular teeth, bluntly rounded and set with small tubercles. The first of these lobes is fully as broad as the outer orbital angle; the second, which is separated from it by a narrow but deep emargination, is much smaller, less than half its breadth; the third is exceedingly indistinct, a scarcely perceptible protrusion of the finely beaded line that marks the margin of the carapace. In the female specimen the antero-lateral borders are not symmetrical. On the left side (text-fig. 9a) there are three lobes, similar to those of the male, but less prominent and separated by shallower emarginations. On the right side (text-fig. 9b) there is only a single large lobe behind the orbital angle.

The surface of the carapace is strongly areolated, the depressed portions being smooth, while those that are elevated bear granules. The granules are small, very close-set in the male, much sparser in the female. A finely beaded line extends from the posterior lobe of the antero-lateral border round the posterior margin of the carapace. The upper orbital margin is not distinctly beaded, but bears scattered granules similar to those on other parts of the carapace; the lower orbital margin is finely crenulate. From either side of the epistome a blunt ridge, covered with granules, extends backwards to a point above the base of the chelipedes (text-fig. 9c). The entire carapace is covered with soft silky hairs, short on the dorsum, longer at the sides and very long beneath the lower orbital margin.

When closed there is a considerable gap between the outer maxillipedes. Both ischium and merus are strongly thickened along their inner margins and both seg-

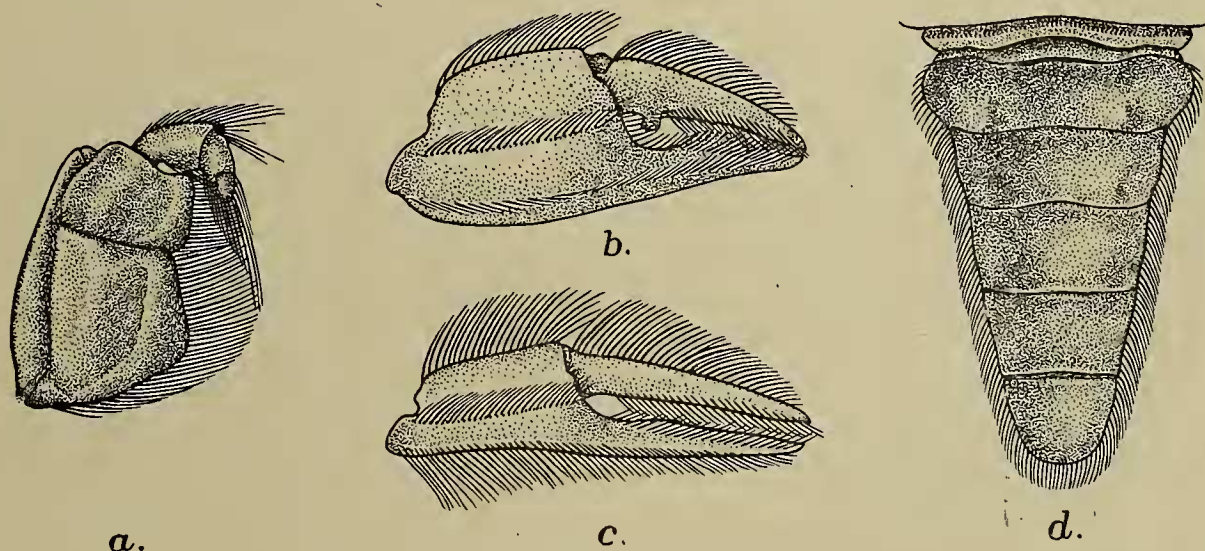


FIG. 10.—*Macrophthalmus gastrodes*, sp. nov.

a. Outer maxillipede.
b. Chela of male.

c. Chela of female.
d. Abdomen of male.

ments show traces of a median longitudinal ridge. The merus is much broader than long and partially overlaps the exopod (text-fig. 10a).

The chelipedes of the male are but little longer than the carapace is broad; in the female they are shorter, about equal to the length of the carapace. The merus is slender, without stridulating crest, and without the expanded and crenulate inner margin found in some species of the genus; it bears two rows of long silky hairs. The dorsal surface of the carpus is pubescent; its inner face and the feebly granulate ventral ridge are set with long hairs. In the male the chela is about two and a half times as long as broad (text-fig. 10b), the fingers being about one and a half times the length of the upper border of the palm. The inner face of the chela does not bear a tubercle and, except for a strip along its lower edge, is covered by a patch of long hairs that extends to the tips of the fingers. Externally the palm is quite smooth, but is traversed by two impressed lines from which setae arise. The uppermost of these runs longitudinally across the middle of the palmar surface and is

continued on the mobile finger. The other is parallel to it and runs close to the inferior margin, extending to the tip of the immobile finger. Neither the upper nor the lower edges of the palm are granulate. In the middle of the fixed finger, on the inner edge, is a large serrated crest, like a cock's comb, with the distal serrations much larger than the proximal. At the base of the dactylus is a strong molariform tooth. The chela of the female (text-fig. 10c) is much more slender, about four times as long as wide, and the fingers are unarmed. It bears rows of setae, similar to those of the male and the surface is covered with a fine pubescence.

The third walking legs are the longest, fully twice the length of the carapace. In all four pairs the upper and lower borders of the meri are granular and on these segments in the first three pairs of the female and the two middle pairs of the male there is on the anterior margin a small sub-terminal spine. The dactyli are flattened and all the segments bear long hairs.

In the male the thoracic sterna bear numerous granules, which also occur, though less abundantly, on the abdomen. In this sex the sutures between the 3rd and 4th and between the 4th and 5th abdominal segments are very fine, the joints being almost immovable, and on either side of these sutures and of that between the 5th and 6th segments there is a large pit or depression (text-fig. 10d). The last segment of the abdomen of the female is about one and half times as broad as long.

Only two specimens of this species were obtained; they yield the following measurements (in mm.):—

	♂	♀
Length of carapace	14.8	17.2
Breadth across outer orbital angles	14.9	17.6
Greatest breadth	17.6	20.8
Breadth of front	2.6	2.7

Macrophthalmus gastrodes is apparently allied to *M. serratus*, White¹, from the Philippine Is. and Hongkong, and to *M. definitus*, White², which is known from the first of these localities and from Australia. It is easily distinguished from both these forms by many of the characters enumerated above.

In life the species is entirely covered with fine mud; when this was removed the specimens were found to be of an almost uniform clay colour with a purplish-pink flush on the carapace. The scarcity of the species in our collection is perhaps due to the fact that it burrows; in both individuals, however, the cornea is jet-black.

Both specimens were found in the outer channel of the Chilka Lake, on the muddy ground between Satpara and Barhampur I. The male was obtained in March in water as salt as that of the Bay of Bengal in the vicinity of the lake-mouth (sp. gr. 1.0265), while the female was found in September in water that was quite fresh.

The two specimens, types of the species, bear the numbers 9157-8/10 in the Indian Museum Register.

¹ Adams and White, *Crust. Voy. 'Samarang'*, p. 51 (1848) and Stimpson, *Smithson. Misc. Coll.* XLIX, p. 96, pl. xiii, fig. 3 (1907).

² Adams and White, *ibid.*, p. 51 (1848) and Ortmann, *Zool. Jahrb., Syst.*, X, p. 342 (1897).

Family GRAPSIDAE.

In addition to purely marine species this family includes numerous forms characteristic of backwaters and estuaries, some aquatic, some amphibious and some almost wholly terrestrial. A considerable number of species are known to exist in water of low salinity and some have succeeded in establishing themselves in fresh water. In the Andaman Is. for instance, *Ptychognathus andamanicus*, Alcock, lives in streams far above tidal influence, while *Sesarma thelxinoë*, de Man, was described from an altitude of 700 ft. In the case of the Andamans, migration from salt to fresh water is perhaps more easily accomplished than in other parts of India, for Potamonidae are entirely absent and the Grapsids are not therefore brought into direct competition with other crabs. As is pointed out on p. 233 the presence of Potamonidae appears to play an important part in hindering *Varuna litterata* from establishing itself in Lower Bengal.

It is remarkable that the genus *Metaplex*, which is abundant in the Gangetic delta and also occurs in backwaters near Madras, is not represented in the fauna of the Chilka Lake.

Subfamily GRAPSINAE.

Genus PACHYGRAPSUS, Randall.

Pachygrapsus propinquus, de Man.

1908. *Pachygrapsus propinquus*, de Man, *Rec. Ind. Mus.*, II, p. 216, pl. xviii, fig. 2.

Although many of the specimens of this species obtained in the Chilka Lake are very much larger than the types, they do not differ in any marked features from them or from the exhaustive description which de Man has supplied.

The anterior part of the gastric region of the carapace and the frontal lobes are beset with small tubercles which, posteriorly, tend to form transverse ridges much more conspicuous than in the types. Adults resemble the original specimens in having the inner margin of the ischium of the outer maxillipedes quite straight.

The chelipedes in the largest individuals are a little unequal; they are, however, identical in structure. The inner edge of the merus bears three or four blunt tubercles at the base and projects distally as a thin crest bearing three or four teeth that decrease in size as they approach the carpal articulation. The spines at the distal end of the lower margin of the merus of the ambulatory legs vary in number from two to four; the dactyli in all are conspicuously shorter than the propodi. The propodus in the penultimate pair is three and a third times as long as broad, the dactylus being about two-thirds its length.

The largest individual is a female in which the carapace is 23.0 mm. in length and 28.8 mm. in breadth. In the largest male the length is 16.4 mm. and the breadth 20.0 mm.

The colour of the species when alive was striking. The dorsal surface of the carapace was dull olive, boldly mottled with dark purple. The chelipedes were deep violet, shading to orange red on the fingers, while the ambulatory legs were olive

brown with dark purple marginal spots, specially well defined on the propodus. The ventral surface was of a dull olive tone, paler than the back, and the eggs in an ovigerous female were very deep purple, almost black.

Pachygrapsus propinquus is represented in the collection by numerous specimens and appears to be not uncommon at the edge of the lake in those places where a stony foreshore exists. It is a very active species and difficult to catch in numbers; it lives for the most part under stones, but in wet weather may be found running on the shore or on rocks. In the main area of the lake, specimens were obtained in company with *Varuna litterata*, at Barkul, on Barkuda and Cherria Is. and on the rocks at the foot of Ganta Sila. In the outer channel the species was found on three occasions; in March 1914, when the water was as salt as that of the Bay of Bengal, two individuals were obtained clinging to one of the posts that serve to mark the deep water passage near Satpara, and in September and December of the same year specimens were found on the oyster-bed opposite Manikpatna. In September, when the water on the oyster-bed was quite fresh, only a single individual was discovered; but in December, when the water was more saline (sp. gr. 1.0125), numerous young, including specimens in the megalopa stage, were obtained.

The species is common in the Ennur backwater, near Madras, sheltering under blocks of laterite piled up to protect the shore from erosion, and in dull weather running about on these rocks throughout the day.

Ovigerous females found in the lake were obtained at Cherria I. in April and at Barkul in July in water of specific gravity 1.00975 and 1.0075. In the Ennur backwater, near Madras, Dr. Annandale found several ovigerous females in January in water of rather lower density (sp. gr. 1.0025).

The only other known examples of *Pachygrapsus propinquus* are those described by de Man and obtained in brackish pools at Port Canning in the Gangetic delta.

Subfamily VARUNINAE.

Genus VARUNA, Milne-Edwards.

Varuna litterata (Fabricius).

1900. *Varuna litterata*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 401.

This abundant species is not particularly common in the Chilka Lake, though it may be found in some numbers in suitable localities. It seems to prefer a situation close to the water's edge, where some cover, either stones and boulders or the stems and roots of plants, is available. Such amenities are rare on the shores of the lake, the margin of the main area being for the most part bare mud or muddy sand and that of the outer channel muddy sand or sand. At the southern end of the lake, however, more especially on Barkuda, Cherria and Chiriya Is. and at the base of Ganta Sila, the foreshore is stony and in these localities *Varuna litterata* is not uncommon. At the close of the monsoon, when the water is fresh and in many places reaches to the roots of the screw-pines and other vegetation, suitable cover is afforded for a short period and a few specimens were taken in such situations.

The species does not as a rule reach a large size in the lake. The carapace of a female of quite exceptional dimensions is, however, 50 mm. in length. Ovigerous females were not found.

In the Gangetic delta *Varuna litterata* is very much more abundant. Every year at the commencement of the monsoon the waters of the Hughli river in the vicinity of Calcutta teem with young specimens in the megalopa stage. They occur in myriads in all places where the current is sluggish and the water slightly salt and are particularly abundant in the numberless small creeks and backwaters subject to tidal influence. The fact that we never found such larvae during our survey of the lake is strong evidence that the species does not breed there.

It appears that *Varuna* is attempting by two methods to establish itself in fresh water in the neighbourhood of Calcutta and the two modes of invasion may be described respectively as aquatic and terrestrial.

The enormous numbers of young produced in the brackish water are borne, either by their own efforts or by the influence of currents to points where the water is almost or quite fresh, at any rate at certain seasons of the year, and though it appears that the species has not hitherto been able to establish itself in fresh water by this means, the attempt is made annually by countless multitudes. The pipes of the Calcutta unfiltered water-supply have been found completely choked by *Varuna* in its megalopa stage.

The terrestrial method of invasion is adopted by adults. Almost every year the tank (or artificial pond) in the Indian Museum compound, normally inhabited by a Decapod fauna consisting of *Parathelphusa spinigera*, Wood-Mason, *Palaemon carcinus*, Fabr., and *Palaemon lamarrei*, M.-Edw., is visited by stray individuals of the species and large specimens have been seen on the banks vigorously warding off the attacks of crows. To reach this tank the crabs must make their way by night through the streets of the city, probably along the gutters. Specimens have also been found in fresh water in other parts of the delta, but there is no evidence that the species has ever established itself permanently in this medium. That it may eventually succeed in its efforts is not improbable, for a number of Grapsidae are known exclusively from fresh water. In the Gangetic delta the change from salt water is perhaps a minor difficulty; the hordes of Potamonid crabs, which already occupy the desired territory, may prove a more formidable obstacle.

Henderson records the common occurrence of this species at the Ennur back-water, where many other species included in the Chilka fauna are abundant; Dr. Annandale, however, was unable to find specimens there in January 1915.

Alcock¹ notes that *Varuna litterata* is frequently found clinging to logs of drift-wood in the open sea, a fact which accounts for its wide distribution. The species is known from an area extending from the east coast of Africa to New Zealand, Australia and Japan.

¹ Alcock, *A Naturalist in Indian Seas*, London, p. 75 (1902).

Genus **PTYCHOGNATHUS**, Stimpson.**Ptychognathus onyx**, Alcock.

1900. *Ptychognathus onyx*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 404, and *Illust. Zool. 'Investigator'*, *Crust.*, pl. lxxv, figs. 2, 2a (1902).

1905. *Ptychognathus onyx*, de Man, *Proc. Zool. Soc., London*, II, pp. 542-544 (key to species).¹

This species, hitherto known from two young males "probably from Tavoy", is represented in the Chilka Lake collection by two females and three adult males.

Due allowance being made for age and sex, the examples agree closely with the type specimens and with Alcock's description and figures.

In the adult male, as in the younger type specimens, the exopod of the outer maxillipedes is scarcely broader than the endopod. In the chelipedes there is a dense patch of hair on the lower surface of the merus at its inner and distal ends², the carpal

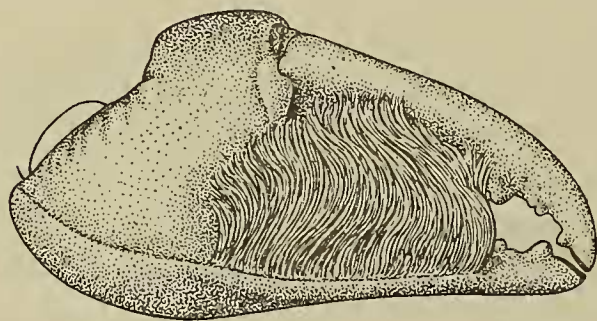


FIG. 11.—*Ptychognathus onyx*, Alcock.

Chela of male, external view.

spine is very strongly developed and the chelae, which are greatly swollen, are nearly as long as the carapace. The palm is covered externally with microscopic granules, so arranged as to form a reticulate pattern and the surface is rather conspicuously puckered near the point of attachment of the carpus. The fingers are two and a half times the length of the upper border of the palm; though pointed, they are slightly hollowed

at the tip and are provided with a series of strong teeth, one of which, near the middle of the fixed finger, is larger than the rest. On the outer surface of the palm a conspicuous and slightly sinuous ridge extends from the base to the tip of the fixed finger and the space between this ridge and the teeth in the finger cleft is occupied by a dense patch of hairs similar to that on the merus (text-fig. 11). The mobile finger is not grooved and does not bear a patch of hair, thus differing from *P. barbatus* (A. Milne-Edwards) and *P. pusillus*, Heller.

In the abdomen of the male the penultimate segment is very much broader than the ultimate and its distal angles are sharply and obliquely truncate (text-fig. 12).

Males of this genus are readily determined by the use of the excellent key which de Man has supplied (*op. cit.*). In that which he has given for the identification of females, the present species is omitted, the sex being up till now unknown. Females of *P. onyx* would in this key take place alongside *P. dentata*, de Man, both being separated from *P. riedeli*, A. M.-Edw., and *P. andamanicus*, Alcock³, by the much

¹ Since this key was published two other species have been described: *P. easterana*, Rathbun, *Mem. Mus. Comp. Zool.*, XXXV, p. 31, pl. ii, fig. 4; pl. vii, figs. 4, 4a (1907) and *P. johannae*, Rathbun, *Proc. U. S. Nat. Mus.*, XLVI, p. 354, pl. xxx. The latter species, said to be closely related to *P. riedeli*, is apparently still more closely allied to *P. barbatus* and *P. pusillus*.

² This patch is also to be seen in the type specimens, but is not nearly so well developed.

³ De Man has suggested that *P. andamanicus* and *P. riedeli* are synonymous. I have examined the types of the former species, but have not seen examples of the latter.

less conspicuous tothing of the antero-lateral margin of the carapace, by the presence of distinct epigastric lobes and by the proportionately narrower exopod of the outer maxillipedes.

Females of *P. onyx* bear a very close resemblance to females of *P. dentata*; but in the former the carapace is very much flatter both fore and aft and from side to side, its regions are less pronounced, the frontal margin straighter and the upper border of the orbit much less sinuous. The ischium of the outer maxillipedes is proportionately a little broader and there is only a slight prominence, in place of a tooth, in the middle of the anterior border of the buccal cavern. In females of *P. onyx*, also, the movable finger of the chela is deeply grooved¹, whereas it is almost smooth in *P. dentata*, and, on the outside of the fixed finger, sparse hairs, absent in *P. dentata*, are to be found in the position occupied by the dense furry patch in the other sex.

In the largest adult male the length of the carapace is 14.2 mm. and its greatest breadth 15.6 mm., in the two females the lengths are 11.2 and 8.4 mm. and the breadths 12.0 and 8.8 mm., respectively.

The colouration is apparently very variable. The carapace of the male was, in life, of a dull greyish-green tone with pale spots and mottled with darker grey and dull maroon. One female was pale olive yellow and the other dull grey, in both cases with a few obscure dark markings.

Ptychognathus onyx was only found on two occasions in the Chika Lake. Three individuals were taken together in the outer channel on a mud bottom off the village of Mahosa on Barhampur I. in September 1914. The depth was between 6 and 8 ft. and the water at the time of their capture was perfectly fresh. In December of the same year two additional specimens were found on the oyster-bed near Manikpatna in water of sp. gr. 1.0125. The species is evidently very scarce; but is probably to be found in the locality at all seasons of the year, enduring changes of salinity varying from fresh to water as salt as that of the open sea in the vicinity.

As has already been stated, the types and only other known examples of the species were probably obtained at Tavoy on the other side of the Bay of Bengal.

Genus CAMPTANDRIUM, Stimpson.

1858. *Camptandrium*, Stimpson, *Proc. Acad. Sci. Philadelphia*, X, p. 106.

1907. *Camptandrium*, Stimpson, *Smithson. Misc. Coll.*, XLIX, p. 137.

1910. *Camptandrium*, Rathbun, *Danske Vidensk. Selsk. Skrifter* (7), *Naturvid. og math.*, V, p. 325.

This genus, hitherto unrecorded from the coast of British India, was originally placed by Stimpson in a separate family; but its affinities are evidently with the

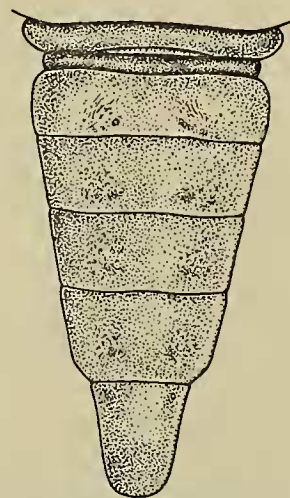


FIG. 12.—*Ptychognathus onyx*,
Alcock.

Abdomen of male.

¹ There is a striking difference between the sexes in this respect.

Grapsidae and Miss Rathbun's view that it should be classed with the Varuninae has much to recommend it, though it must be admitted that it is a very aberrant member of the subfamily.

Camptandrium differs from the description of the Varuninae as given by Alcock¹ in having the sub-orbital crest and the lower border of the orbit closely adjacent and in the form of the outer maxillipedes. Only a very small gap remains between these appendages when they are closed and their exopod is slender and partially concealed by the merus. The slender exopod forms a ready means of distinguishing the genus from *Varuna*, *Ptychognathus* and *Pyxidognathus* the only other Indian genera of Varuninae. The hexagonal form of the carapace with its oblique and well-marked antero-lateral margins gives the genus a facies very distinct from that of the more typical representatives of the subfamily, to which, however, it is in some degree linked by Dana's *Cyrtograpsus*.

Camptandrium sexdentatum, Stimpson.

(Plate XII, fig. 6.)

1858. *Camptandrium sexdentatum*, Stimpson, *Proc. Acad. Sci. Philadelphia*, X, p. 107.

1907. *Camptandrium sexdentatum*. Stimpson, *Smithson. Misc. Coll.*, XLIX, p. 138, pl. xvii, fig. 4.

Three specimens of this species were obtained in the outer channel of the Chilka Lake, two young males and a large female, the latter, although dead when brought to the surface and with the carapace detached from the body, being nevertheless in a fair state of preservation. The illustration on pl. xii (fig. 6) is of a young male, the carapace of the female is shown in text-fig. 13.

In most particulars the specimens agree very closely with Stimpson's admirable description; on careful comparison with his account I am only able to detect a few minor discrepancies.

The margin of the front is slightly emarginate in the middle when viewed from above and the dorsal surface of the carapace might more correctly be described as unequal with only two conspicuous transverse interrupted ridges. The surface is

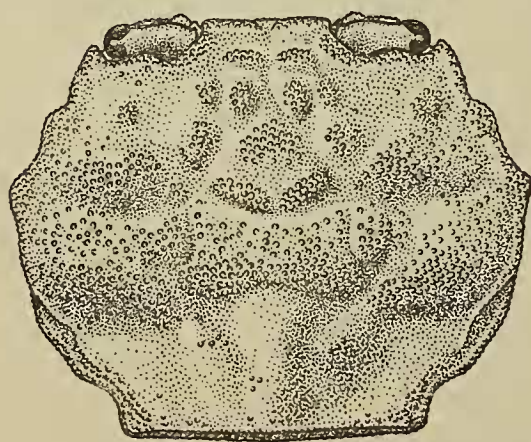


FIG. 13.—*Camptandrium sexdentatum*,
Stimpson.

Carapace of female.

finely setose in both sexes and all the more elevated portions bear minute granules. The anterior transverse ridge consists in reality of three largish tubercles, the median of which is interrupted in the middle and is placed at the hinder end of the gastric region. This is clearly shown in Stimpson's figure, in which the more prominent ridge across the cardiac and branchial regions is also exactly indicated. The true infero-lateral margin of the carapace is visible in dorsal view at the base of the last two pairs of legs; the postero-lateral margin is granular and, though convex, is markedly sinuous, while

¹ Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, pp. 288, 389.

the posterior margin, also granular, is perfectly straight and terminates in a rectangular or acute angle on either side. Of the teeth on the antero-lateral margin the first (which corresponds with the outer orbital angle) and the third are more or less acute; the second is smaller and bluntly rounded. The teeth are sharper in the young males than in the adult female. The upper orbital margin is conspicuously elevated, both at the side of the front and behind the eye, the latter border being strongly sinuous. The lower border of the orbit, as Stimpson has explained, bears a small dentiform lobe internally; the margin is well developed and not deficient as in *Varuna*.

The external maxillipedes are precisely as described by Stimpson. Compared with Miss Rathbun's figure of the appendage in *C. paludicola*, the ischium is more quadrate, equal in length to the merus, and the division between the two segments is straighter and more oblique (text-fig. 14).

The chelipedes in all the specimens are small, weak and shorter than the carapace. The carpus is a little shorter than the palm. The chela is very slender and the fingers are about as long as the palm in the female, a trifle longer in young males. They are slightly curved in dorsal view and are very deeply channelled internally throughout their length, so much so that each resembles a greatly elongated spoon.

The first and last walking legs are about equal in length—a little longer than the carapace; the second and third pairs are about one and three quarters the length of the carapace. The merus is more slender than is shown in Stimpson's figure; the ridge near the upper margin is conspicuous and granular. The upper edge is also granular and in young males bears a minute subterminal spinule on the two middle pairs, much smaller than that found in *C. paludicola* and apparently wholly absent in the female. The inferior surface of the merus is provided with two granular longitudinal ridges separated by a comparatively broad interspace. The dactyli are about equal in length with the propodi.

The sternum agrees exactly with Stimpson's description. In the young males the abdomen has a wavy outline, the margin being concave opposite each sternal segment and convex opposite the interspaces of the segments; it could hardly be described as "strongly constricted and sinuated on each side at the middle", but the form is probably subject to change during growth. Except for the most distal one, the sutures between the abdominal segments can scarcely be detected in the larger male example, they are more distinct in the small individual. The sutures in the abdomen of the adult female are conspicuous and markedly sinuous in the middle. The margin of the abdomen is, in this sex, thickly fringed with plumose hairs and, in all the specimens, a number of similar hairs are to be found on the walking legs.

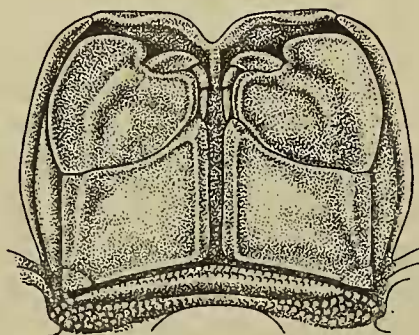


FIG. 14.—*Camptandrium sexdentatum*,
Stimpson.

Third maxillipedes of young male.

The carapace of the adult female is 7.4 mm. long and 9.4 mm. broad. Its length in the two males is 3.4 mm. and 2.5 mm. The males were, in life, of a dull grey colour, faintly mottled with brown.

The specimens from the Chilka Lake were all found in the outer channel on a muddy bottom, between Satpara and Barhampur I. at a depth of from 1-2 fathoms. At the time they were obtained the water was quite fresh. I have no doubt that they are also to be found in the same locality when the channel is flooded with salt water from the Bay of Bengal; the fact that the species was not met with during March is sufficiently explained by the rarity of its occurrence.

Two minute examples of *Camptandrium sexdentatum* (carapace-length 2.3 mm. and 1.7 mm. respectively) were obtained by Dr. Annandale in the Ennur backwater, near Madras, in January 1915, in water of specific gravity 1.0025.

Stimpson's type specimens are recorded "from a muddy bottom at the depth of six fathoms, in bays of the coast near Hongkong, China."

Subfamily SESARMINAE.

Genus SESARMA, Say.

Sesarma tetragonum (Fabricius).

1900. *Sesarma tetragonum*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 420.

A single example of this species, a male with carapace 29 mm. in length, was found dead on an island in the outer channel near Manikpatna. It was obtained in March 1914, at the time when the water in the channel was salt. The species is, in all probability, only an occasional visitor to the lake-system; it may possibly establish itself for short periods, but of this we have no evidence.

Sesarma tetragonum is a species of very wide Indo-pacific distribution.

Sesarma batavicum, Moreira.

. (Plate XII, fig. 7.)

1890. *Sesarma barbimana*, de Man (*nec* Cano), *Notes Leyden Mus.*, XII, p. 104, pl. vi, fig. 13.

1903. *Sesarma batavica*, Moreira (*nom. nov.* for *S. barbimana*, de Man, *nec* Cano¹), *Arch. Mus. Rio Janeiro*, XII, p. 117. (*fide* Zool. Rec. for 1903.)

The specimens from the Chilka Lake, though rather smaller than the type, agree closely with de Man's description and figure.

The small transverse rows of setae on the carapace are easily seen and are especially conspicuous in life, for each seta is finely plumose and usually retains a quantity of soft mud. The oblique ridges at the sides of the carapace, as de Man has noted, are very similar to those of *S. andersoni*, de Man (the types of which I have examined). The anterior ridge sometimes, but not always, projects a trifle beyond the lateral

¹ Cano, *Boll. Soc. Nat. Napoli*, III, p. 245 (1889).

margin, forming a very rudimentary tooth behind the outer orbital angle. In *S. andersoni* a short ridge is to be found on either side of the carapace strictly transverse in direction and situated close behind the middle of the orbit. Of this in *S. batavicum* there is no trace.

The chelipedes are almost or quite equal. In the largest specimens the ischium bears a small blunt anterior tubercle and, in all, the antero-inferior edge of the merus is produced distally in the form of a thin triangular crest, apically blunt or rounded and anteriorly serrate. The inner angle of the carpus is rectangular; behind it on the postero-internal face of the segment there is, in both sexes, in addition to the short black hairs on the upper surface noticed by de Man, a linear series of very long stiff setae, also black in colour, and a row of similar but shorter setae extends diagonally across the smooth inner face of the merus. The palm of the chela bears on its upper surface the characteristic ridges figured by de Man. In the male the outermost and best developed of these ridges extends in a sinuous line from the inner end of the dactylar articulation to a point close to the mid-dorsal projection of the carpus (text-fig. 15*b*). This ridge is composed of horny tubercles, the anterior of which are very high and upstanding. Inwards of this limiting ridge are several others, also tubercular but for the most part shorter. One of these defines the margin of the hand and, in the space between it and the primary ridge, and more or less parallel with portions of the latter are two or three other ridges and a few odd tubercles. Below the marginal ridge on the upper and inner face of the palm are other less conspicuous rows of tubercles. The precise arrangement of the ridges is somewhat variable; it corresponds comparatively closely with de Man's figure, though one would gather from his description that only two dorsal ridges existed. The tuft of hairs found on the outer surface of the fingers is conspicuous in all males (text-fig. 15*a*), but, owing perhaps to the small size of the specimens, does not occupy such a long area in lateral view as is shown in the original figure. The hairs extend through the base of the finger-cleft and are visible on the inner side. The fingers in other respects agree in the closest manner with de Man's description, but possess more teeth, often as many as six, on their cutting edges.

The chela of the female bears on the upper surface ridges closely comparable to those of the male; there are, however, only a few sparse hairs at the base of the

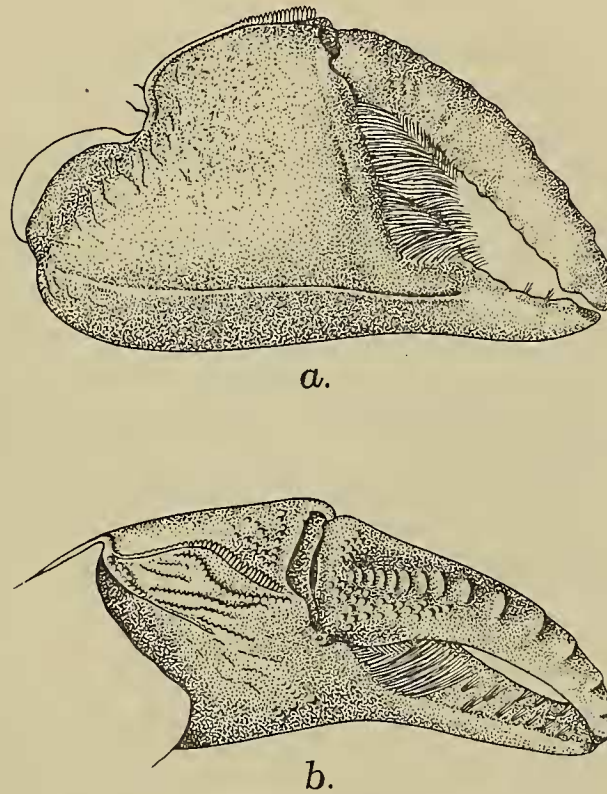


FIG. 15.—*Sesarma batavicum*, Moreira.

a. Right chela of male, external view.

b. Left chela of male, viewed obliquely from above.

finger-cleft and the upper edge of the dactylus is quite smooth, showing no indication of the transverse ridges or tubercles possessed by the male.

The ambulatory legs are a little shorter and broader than in *S. andersoni*, but are much more hairy than in that species; in particular the anterior borders of the carpi and propodi are covered with a dense coating of coarse setae of varying length. The meral segments bear a small tooth at the distal end of their anterior margin and a group of two or three teeth in a similar position on the posterior margin¹.

The abdomen of the male is decidedly narrower than in *S. andersoni*.

The length of the carapace in the largest specimen from the Chilka Lake, a male, is 7.5 mm. and its breadth 9.6 mm.

This species, which has not hitherto been found on the coast of British India, belongs to the subgenus *Parasesarma* of de Man's terminology² and is one of a small group of five species readily distinguished from the others by the presence of spines on the ambulatory legs at the distal end of the posterior margin of the merus. In 1890 de Man (*loc. cit.*, pp. 97, 98) gave a key to the species of *Parasesarma* then known, three forms belonging to the *andersoni* group being included. Later, in 1909, Calman³ supplied some valuable notes on the species of the group in his description of *Sesarma murrayi*. *Sesarma batavicum* is readily separated from all its allies by the use of characters derived from the chelae; the arrangement of the ridges on the upper surface of the palm and the presence in the male of a tuft of hairs in the finger-cleft.

Moreira's choice of '*batavica*' as a new name for this form is not a happy one, for de Man, in the same paper that contains his description of *S. barbimana*, has described another species of the genus under the name of *S. bataviana*.

Sesarma batavicum is represented in our collection by many specimens found among the clusters of shells on the oyster-bed in the outer channel opposite Manikpatna. Specimens were obtained on every occasion on which the bed was examined, in March, September and December, both when the water was fresh and when it was as salt as the sea outside the lake. None of the females are ovigerous.

The species is very abundant in the natural cavities of laterite blocks in the Ennur backwater near Madras, where, as in the Chilka Lake, it appears to be entirely aquatic in habits. It was found at Ennur also, amongst clumps of oysters. The specimens are larger than those from the Chilka Lake; the carapace of a male being 8 mm. long and 10.2 mm. in breadth; the collection was made in January 1915, in water of specific gravity 1.0025, and includes a number of ovigerous females.

The only other specimen known is the individual described by de Man and found on the sea-shore at Batavia.

¹ The teeth found in *Sesarma murrayi* at the *proximal* end of this margin are not present in *S. batavicum*.

² De Man, *Notes Leyden Mus.*, XII, p. 97 (1890) and *Zool. Jahrb., Syst.*, IX, p. 181 (1895).

³ Calman, *Proc. Zool. Soc., London*, p. 709 (1909).

Subfamily *PLAGUSIINAE*.Genus *PLAGUSIA*, Latreille.*Plagusia depressa* (Fabricius), subsp. *tuberculata*, Lamarck.

1900. *Plagusia depressa* var. *squamosa*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 437.
1906. *Plagusia depressa* vars. *tuberculata* and *immaculata*, Laurie, *Rep. Pearl Oyster Fisheries, Ceylon*, V, pp. 429, 430.
1906. *Plagusia depressa tuberculata* and *P. immaculata*, Rathbun, *Bull. U.S. Fish Comm. for 1903*, III, pp. 841, 842.
1907. *Plagusia orientalis* and (?) *P. depressa*, Stimpson, *Smithson. Misc. Coll.*, XLIX, p. 122.
1910. *Plagusia tuberculata*, Rathbun, *Proc. U.S. Nat. Mus.*, XXXVIII, p. 590, and footnotes to references by Stimpson (*op. cit.*).
1910. *Plagusia depressa tuberculata*, Rathbun, *Danske Vidensk. Selsk. Skrifter* (7), *Naturvid. og math.*, V, p. 330.

As Laurie and Miss Rathbun have remarked it is probably best, in view of the uncertainty that exists regarding the identity of Herbst's *Cancer squamosus*, to avoid the use of that term as a varietal or sub-specific name. Examination of the specimens in the Indian Museum leads me to believe that Alcock was right in refusing to recognise more than one form of the species in Indian waters. The series shows every possible intergradation between the vars. *tuberculata* and *immaculata* as defined by Laurie.

The only individual obtained in the Chilka Lake is extremely small, the carapace being 7 mm. in length. The tubercles on the dorsal surface are much depressed, but are heavily fringed with setae.

The specimen was obtained in the outer channel in March 1914, at the time when the water was salt. It was found clinging to a pole that served to mark the deep water passage in the vicinity of Satpara. No specimens were observed when the water was fresh and the species is doubtless to be regarded as a casual visitor to the lake-system.

The subspecies *tuberculata*, which is frequently found on floating timber far out at sea, has a very wide Indo-Pacific distribution, extending from the Red Sea and East Africa to the western coasts of America from Lower California to Chili.

Family *GEOCARCINIDAE*.Genus *CARDIOSOMA*, Latreille.*Cardiosoma carnifex* (Herbst).

1900. *Cardiosoma carnifex*, Alcock, *Journ. Asiat. Soc. Bengal*, LXIX, p. 445.
1907. *Cardiosoma carnifex*, Rathbun, *Mem. Mus. Comp. Zool., Harvard*, XXXV, p. 26.

The two specimens found in the Chilka Lake agree closely with other examples in the Indian Museum and differ from *C. hirtipes*, Dana¹, in the characters noted by Alcock and Miss Rathbun. There seems, however, to be some variation in the degree

¹ Miss Rathbun [*Bull. U.S. Fish Comm. for 1903*, pt. 3, p. 838 (1906)] identifies this species with the earlier *Thelphusa rotunda* of Quoy and Gaimard.

of hairiness of the ambulatory legs. In the specimens from the Chilka Lake the hairs are much more numerous than in an individual from the Andamans and occur over almost the entire length of the upper border of the merus.

Miss Rathbun¹ has given a fresh diagnosis of the allied West Indian *C. guanhumi*, Latreille, which leads me to suppose that the species is distinct from *C. carnifex*.

The two specimens are both males and are 61.5 and 62.5 mm. in length and 73.5 and 74 mm. in breadth.

The colour in life is striking. The dorsal surface of the carapace is livid purple with a close and fine reticulation of yellowish-green which gradually disappears towards the sides and is densest in the central part of the cardiac region. The hepatic regions and the sides of the carapace are lilac. The ventral surface is cream-coloured, the epistome tinged with purple. The chelipedes are cream-coloured, deepening to yellow on the palm and fixed finger and suffused on the dorsal surface of the merus and carpus with purple. The extreme tips of the fingers are brown. The basal joints of the walking legs are yellowish; the merus, carpus and propodus are deeply tinged with purple and bear dark brown hairs; the dactylus is orange yellow.

Colonies of this species inhabit the islands in the outer channel near Manikpatna. In March 1914, when the water was low and as salt as that of the sea outside the lake, large burrows of *C. carnifex* were found, their mouths often four or five inches in diameter. Similar burrows were noticed below the surface of the water in the vicinity and, on the shore, fragments of specimens that had been eaten by birds were abundant. In September, when the water in the outer channel was fresh, the species was also in evidence, but on this occasion, owing to the rise in the water-level, most of the burrows were below the surface. The crabs seem to live at a considerable depth in the mud and, as a rule, do not wander by day; it was in consequence difficult to obtain specimens.

Family XANTHIDAE.

Genus HETEROPANOPE, Stimpson.

1898. *Heteropanope*, Alcock, *Journ. Asiat. Soc. Bengal*, LXVII, p. 207.

1907. *Heteropanope*, Stimpson, *Smithson. Misc. Coll.*, LXIX, p. 62.

Heteropanope indica, de Man.

1888. *Heteropanope indica*, de Man, *Journ. Linn. Soc.*, XXII, p. 53, pl. iii, figs. 1, 2.

1898. *Heteropanope indica*, Alcock, *Journ. Asiat. Soc. Bengal*, LXVII, p. 208.

I have compared the specimens in the collection with the individual recorded by Alcock, apparently one of the two examples on which de Man based his original description, and find them in perfect agreement.

¹ Rathbun, *Bull. U. S. Fish Comm. for 1900*, XX, pt. 2, p. 15 (1902).

The larger chelipede of the female, which de Man was unable to examine in the material at his disposal, is as large as that of the adult male; but the carpus, instead of being smooth, is coarsely and irregularly granulate, the granules forming definite rows or groups near the distal margin. The palm also bears definite granules on its upper edge and on the outer surface at the base of the fingers.

The figure given by de Man is a trifle misleading, for the species is represented a little longer and less transverse than it really is and there is only a faint indication of the transverse granular ridge in the vicinity of the third tooth of the antero-lateral margin. This ridge, which is conspicuous in all the specimens, is of some importance, as it is absent in the closely allied species *H. africana*, de Man.¹ In our specimens the chelae are of a uniform dull yellowish or brownish colour, with the fingers black from tip to base; I have not seen any individual in which the colour resembles that shown in de Man's figure.

Heteropanope indica is represented in the collection by twenty specimens. The carapace in the largest example, a male, is 15.2 mm. in length and 22.2 mm. in breadth. In ovigerous females the carapace varies from 9.6 to 14.4 mm. in length.

With the exception of a single individual found on a post, placed to mark the position of the deep water passage near Satpara, all the specimens were obtained on the oyster-bed in the vicinity of Manikpatna. They were found living in the dead and gaping shells and in the chinks and crannies between them and were obtained both when the water was fresh and when it was as salt as the Bay of Bengal near the mouth of the lake. The ovigerous females were taken in the months of March and December.

A single specimen was taken by Dr. Annandale in the Ennur backwater, near Madras, in January 1915, also among oysters.

The species was hitherto known only from the two type specimens, obtained in the Mergui Archipelago.

Genus **LEIPOCTEN**, nov.

Carapace but little broader than long, subquadrilateral, slightly convex both fore and aft and from side to side, not or scarcely areolated, sparsely tuberculate and densely tomentose. Antero-lateral borders entire except for isolated tubercles, or cut into one or two blunt crenulate lobes in addition to outer orbital angles. Postero-lateral borders very short.

Front rather less than a third the greatest breadth of carapace, slightly deflexed, not notched in the middle line; the lateral angles prominent in a facial view.

Fronto-orbital border four-fifths the breadth of carapace. Orbits large, without fissures or sutures. Basal antennal segment short and broad, its inner angle touching the front, the flagellum standing in the orbit.

Antennular region and epistome very short in a fore and aft direction; the latter almost obliterated, especially in the middle where the front almost touches the strongly rounded anterior margin of the buccal cavern. Crests of endostome, defining the

¹ De Man, *Bull. Mus. d'Hist. nat. Paris*, VIII, p. 244, text-figs. 1, 2 (1902).

expiratory channels, not very strong but continued to anterior margin. Buccal cavern broader than long; its lateral borders on either side defined by two conspicuous ridges enclosing a deep trough.

External maxillipedes large. Ischium and merus smooth, the former quadrate with concave anterior (sutural) border. Merus about as long as broad, larger than ischium; inner margin strongly curved, outer margin partially overlapping exopod, anterior margin with a small process external to insertion of palp.

Chelipedes equal in both sexes, much larger in the male than in the female. Palm of chela in female sharply spinulose, fingers without teeth internally. Chela of male swollen, for the most part smooth; inner margin of dactylus with one great tooth at proximal end; tips of fingers not spooned. Walking legs short and stout, meral segments somewhat dilated with large spinous tubercles arranged, as seen from below, in a U-shaped figure. Legs shaggy.

Abdomen of male composed of six segments, the first four, though with distinct sutures, apparently forming a single immovable piece.

Type,—*Leipocten sordidulum*, sp. nov.

The affinities of this genus are obscure. The complete character of the endostomial ridges indicates a position in the section Hyperomerista and of the subfamilies that Alcock includes in this section it agrees more nearly with the Eriphiinae than with any other. From the Eriphiinae it differs in the narrower front and shorter postero-lateral borders, in the form of the outer maxillipedes, in the presence of a double keel on either side of the buccal cavern and in the peculiar spinulation of the walking legs. It clearly cannot be classed with any of the "alliances" of Eriphiinae recognised by Alcock and is perhaps better regarded as the type of a distinct subfamily.

Leipocten sordidulum, sp. nov.

(Plate XII, fig. 9.)

The carapace is subquadrilateral, broader than long in the proportion of 19 or 20 to 15. The antero-lateral borders are subparallel, only a little divergent posteriorly, and are nearly one and half times the length of the postero-lateral. The dorsal surface is slightly convex in both longitudinal and transverse directions—more so in females than in males—and shows only the faintest traces of areolation.

When the dense tomentum is removed, the surface is found to be finely pitted and to bear small pearly grey tubercles, extremely variable in their number and disposition. In some female individuals they are more abundant than in the specimen figured on plate xii, covering the entire surface, in others they are less numerous, while in males they are frequently altogether absent except in the vicinity of the lateral margin. Certain tubercles near the junction of the antero- and postero-lateral borders and a few above the base of the last legs are, as a rule, larger and more conspicuous than the rest.

Even greater variation is shown in the structure of the antero-lateral border. In

the female figured on plate xii, which is extreme in this respect, the margin only bears large scattered tubercles behind the acute orbital angle ; in other females and in most males the tubercles are aggregated to form one or two protrusions or lobes which, in some cases, are separated by definite emarginations of the border (text-figs. 17b, 17c).

The front is one-third or a little less than one-third the greatest breadth of the carapace and is only very slightly deflexed. Dorsally it exhibits feeble longitudinal depressions in the middle and near the inner border of each orbit, and there are faint indications of a pair of pre-gastric lobes.

The anterior margin is straight in dorsal view ; but, seen from in front, it projects downwards in the middle and at the lateral angles (text-fig. 16).

The fronto-orbital border is about three quarters the greatest breadth of the carapace.¹ The upper margin of the orbit is a little sinuous and is sometimes, but not always, obscurely crenulate in part or in all of its course. The inferior margin is evenly curved and crenulate, meeting the upper margin externally without any appreciable gap or emargination. The side-walls of the carapace beneath the antero-

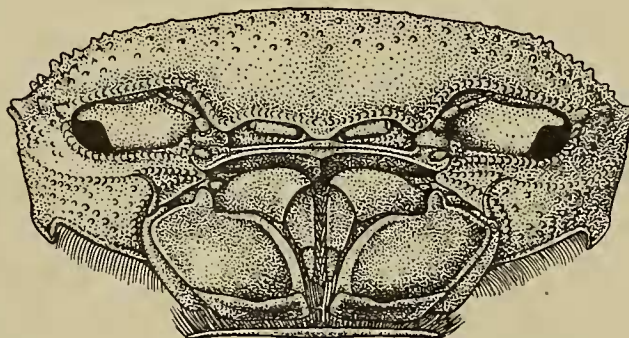


FIG. 16.—*Leipocten sordidulum*, gen. et sp. nov.

Carapace of a female, seen from in front.

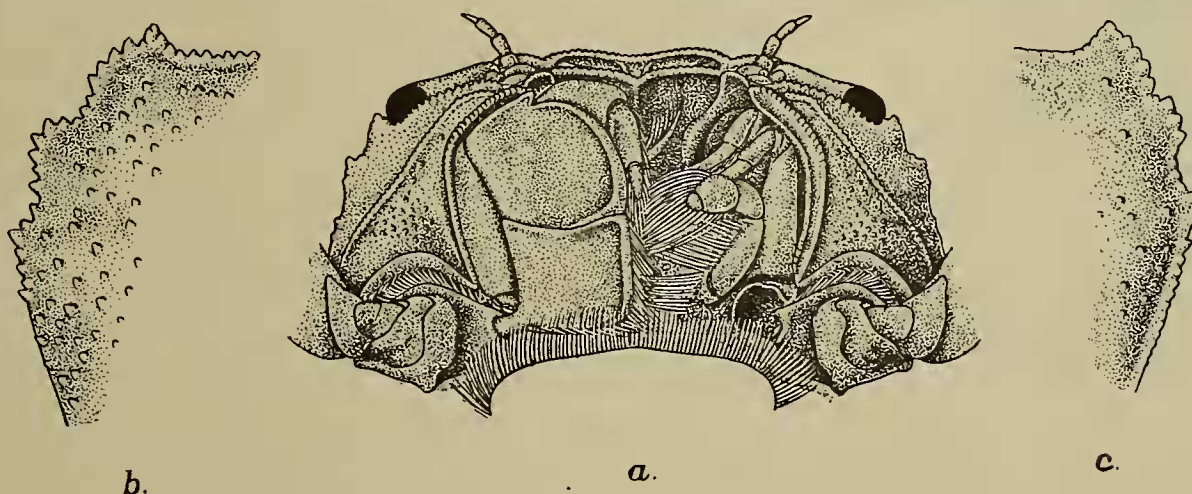


FIG. 17.—*Leipocten sordidulum*, gen. et sp. nov.

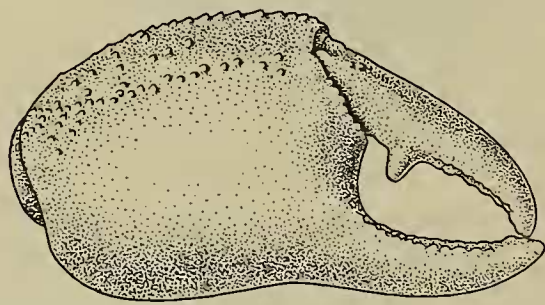
- a. Anterior portion of carapace from below, left outer maxillipede removed.
 b. Antero-lateral margin of carapace of a female from Madras.
 c. do. do. of a male from Madras.

lateral border are smooth or feebly tuberculate and are traversed by a finely beaded line that extends from the outer angle of the epistome to the enlarged tubercles above the base of the last leg. The true infero-lateral border is also finely beaded. The posterior border is straight in both sexes and about as long as the front ; it is traversed by two beaded lines, rather widely separated and continuous with that on the infero-lateral edge.

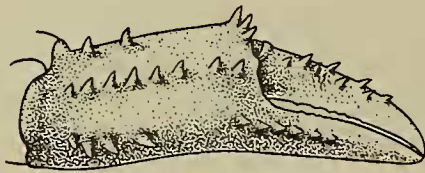
¹ It varies from 0.65 to 0.8 times the greatest breadth.

The opening of the buccal cavern is transversely oval, widest in the middle. Its lateral border is formed by a pair of sharp ridges, that coalesce both in front and behind and enclose a deep trough formed to receive the outer edge of the exopod of the third maxillipedes (text-fig. 17a). The structure of the latter appendages is sufficiently described under the generic heading.

The chelipedes are much larger in the male than in the female, but are symmetrical in both sexes. In the female they are a little shorter, and in the male about a third longer than the breadth of the carapace. The merus is trigonal, with the



a.



b.

FIG. 18.—*Leipocten sordidulum*,
gen. et sp. nov.

a. Chela of male. b. Chela of female.
Tomentum not represented in b.

upper and outer margins serrated and often with a few tubercles beneath; in the male it is about as broad as long. The carpus of the male does not bear a spine at the inner angle; but the inner margins, as seen in dorsal view, are coarsely serrate. In the female the carpus is more elongate; it bears low tubercles or sharp spinules along its inner and distal borders and sometimes a longitudinal row on its upper surface as well. The chelae of the male are greatly enlarged, each is about twice as long as broad (text-fig. 18a). Externally the palm is quite smooth, except that near the carpal articulation there is a patch of low granules which are continued in single row almost to the base of the dactylus. The upper border of the palm also bears granules, irregular in their disposition; the inner surface and the lower border are smooth.

The fingers are not grooved and are not spooned at the tips; in adults they meet only at the tips. Each finger is provided internally with three rows of low and inconspicuous tubercles and at the base of the dactylus, which is a little longer than the upper border of the palm, there is a huge blunt tooth.

The chela of the female is slender and widely different from that of the male (text-fig. 18b). It is more than three times as long as wide and the palm, on its upper border and outer surface, bears three or four rows of large spinules, the lowermost being continued on to the fixed finger. The fingers are not armed internally and meet throughout their length when the claw is closed; the dactylus bears small spines and is a trifle shorter than the palm. The chelipedes of the female are densely tomentose, whereas in the male they are almost bare.

The walking legs are short and stout. The upper surface of the merus bears scattered tubercles, sometimes very conspicuous in the female, less well developed as a rule in males; the anterior border is feebly crenulate. On the posterior border and lower surface of the merus are spinules and tubercles, very characteristic in their disposition (text-fig. 19). The posterior border bears a row of spinules of varying size, one or two being as a rule much larger than any of the others. The row

extends back proximally to a point not far from the articulation of the ischium, then turns across the inferior face of the segment in the form of a series of slender teeth with blunt tips and is continued obliquely outwards to the antero-inferior angle of the mero-carpal joint. In the last part of their course the spinules are widely separated and are reduced to small tubercles; but, close to the carpus, they are more closely set and form a finely serrate crest. The spinules are better developed in the female than in the male; seen from below they present a U-shaped figure, the upper extremities of the U being situated on either side of the mero-carpal joint. The carpus and propodus are short and swollen and bear a few blunt teeth distally. The dactylus is conical and slightly curved.



FIG. 19.—*Leipocten sordidulum*,
gen. et sp. nov.

Fourth peraeopod viewed obliquely from below.

The form of the abdomen in the male and female is shown in text-figs. 20a and 20b.

Except for the chelipedes of the male the entire upper surface of the animal is densely clothed with a fine woolly hair that retains large quantities of mud and can only be removed with considerable difficulty. Interspersed among the hairs are numerous large black bristles.

The carapace of the largest female is 8.1 mm. in breadth, that of the largest male 6.5 mm.

Of this curious and variable species five females only were obtained in the Chilka Lake. All were found hiding among shells on the oyster-bed in the outer channel opposite Manikpatna. Two individuals were taken in March

in water as salt as that of the Bay of Bengal in the vicinity of the lake (sp. gr. 1.0265), one in September in water that was quite fresh and two in December in water of specific gravity 1.0125. One of the specimens found on the last of these occasions is ovigerous.

A fine series of specimens, consisting of ten males and twenty-seven females, mostly ovigerous, was obtained by Dr. Annandale in the Ennur backwater near Madras in January 1915. They were found in cavities in laterite blocks forming a sea-wall, submerged at high water. The specific gravity of the water was 1.0025.

The types of the species bear the numbers 9163-4/10 in the Museum register.

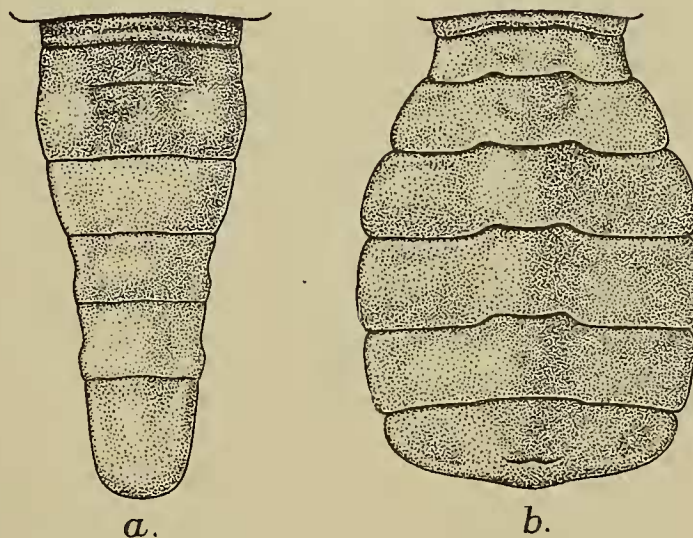


FIG. 20.—*Leipocten sordidulum*, gen. et sp. nov.

a. Abdomen of male.

b. Abdomen of female.

Family PORTUNIDAE.

Genus SCYLLA, de Haan.

Scylla serrata (Forskål).

1899. *Scylla serrata*, Alcock, *Journ. Asiat. Soc. Bengal*, LXVIII, p. 27.

This species is common in the Chilka Lake, in the outer channel and in the main area, at all seasons of the year and is found both when the water is fresh and when it is as salt as the Bay of Bengal in the vicinity.

In young specimens, as Alcock has noted, the frontal lobes are indistinct and there is an interrupted transverse granular line across the gastric region; the latter is conspicuous even in specimens in which the carapace is 50 mm. in breadth.

Scylla serrata is the common edible crab of India and is brought into the markets in great numbers. It is abundant in estuaries, backwaters and mangrove swamps and is evidently able to live in water without a trace of salinity. In the Chilka Lake it must exist in fresh water for several months in the year and large specimens have been taken in the Gangetic delta far beyond the reach of tidal influence. The carapace of a male found under these conditions at Gatiaghar in the Hughli district is 135 mm. in breadth. The species, however, grows to a much greater size than this. In a giant male in the Indian Museum the carapace is 147 mm. in length and 211 mm. in breadth, the length of the larger chela being 195 mm. This individual is, I believe, the largest specimen known.

Examples of the Cirripede, *Dichelaspis cor*, Aurivillius, are commonly found attached to the branchiae of specimens found in the outer channel, but were never obtained on individuals caught in the main area of the lake.

Scylla serrata has a very wide Indo-pacific distribution extending from the Red Sea and the eastern coasts of Africa to Japan, New Zealand and Oceania. It is apparently not found at the Hawaiian Is.

Genus NEPTUNUS, de Haan.

1899. *Neptunus*, Alcock, *Journ. Asiat. Soc. Bengal*, LXVIII, p. 28.

1897. *Portunus*, Rathbun, *Proc. Biol. Soc. Washington*, II, p. 155.

1908. *Lupa*, Stebbing, *Ann. S. African Mus.*, VI, p. 11.¹

Those interested in the question of the suppression of this long established name should consult the papers by Miss Rathbun and Stebbing cited above.

Neptunus pelagicus (Linnaeus).

1899. *Neptunus pelagicus*, Alcock, *Journ. Asiat. Soc. Bengal*, LXVIII, p. 34.

This species is common in the Chilka Lake, both in the outer channel and in the main area; like *Scylla serrata* it is used as an article of food. It is, apparently, unaffected by alterations in salinity and is equally abundant at all seasons of the year.

¹ In this paper Stebbing supports the claims of *Lupa* against those advanced by Miss Rathbun for *Portunus*. To these arguments Miss Rathbun has not, I believe, made any reply, yet continues to use *Portunus* for the species so long known by the unequivocal *Neptunus*, de Haan.

In very young specimens the carapace is proportionately much longer than in adults and the frontal margin is entire and not cut into teeth.

The range of the species in the Indo-pacific region is closely similar to that of *Scylla serrata*.

Genus **THALAMITA**, Latreille.

Thalamita crenata, Latreille.

1899. *Thalamita crenata*, Alcock, *Journ. Asiat. Soc. Bengal*, LXVIII, p. 76.

This species is not uncommon on the oyster-beds at Manikpatna in the outer channel of the Chilka Lake and was found both when the water was fresh and when it was salt. It does not, in our experience, occur in the main area of the lake.

The distribution of *T. crenata* is co-extensive with that of the two preceding species.

Tribe **PAGURIDEA**.

We are indebted to Dr. J. R. Henderson, Superintendent of the Madras Museum, for an account of the hermit-crabs of the Chilka Lake.¹

The species identified by Dr. Henderson are seven in number. One of these is a form hitherto unknown, which is described under the name of *Clibanarius olivaceus*, and another, *Diogenes miles* (Herbst), is represented by a single individual obtained on the sea-shore near Rambha. The latter species is not a member of the lake fauna proper; it may perhaps wander at times to the shores of the outer channel, though we never found it there.

It is noteworthy that most of the Paguridea found in the lake are represented only by very small specimens. This is possibly due to the fact that their environment, with its great seasonal changes in salinity, hinders a more complete development; but it seems more probable that it is caused by the absence of any shells large enough to accommodate full-grown specimens. Except for a few *Telescopium fuscum*, found in the outer channel and frequently inhabited by moderate-sized *Clibanarius padavensis*, the largest gastropod both in this part of the lake and in the main area is *Thais* (= *Purpura*) *carinifera*, a shell much too small to accommodate large individuals of any species except *Diogenes avarus*. In the main area the distribution of *Thais* is restricted and coincides with that of *Clibanarius*.

Family **PAGURIDAE**.

Genus **CLIBANARIUS**, Dana.

The three species of this genus found in the Chilka Lake are very closely allied to one another; but, as Henderson has pointed out, are readily distinguished by their colouration. *C. padavensis* and *C. longitarsis* are very widely distributed forms, and all three are essentially inhabitants of brackish water.

¹ Henderson, *Rec. Ind. Mus.*, XI, p. 25 (1915).

Clibanarius padavensis, de Man.

1915. *Clibanarius padavensis*, Henderson, *Rec. Ind. Mus.*, XI, p. 25.

This species, which has frequently been recorded from brackish water, is abundant at the south end of the lake, where it may be found crawling on the rocks at the base of Ganta Sila and on Breakfast I. It is also common in the outer channel, from Satpara at least as far as Manikpatna.

As is the case with all the Pagurids found in the lake, the species seems unable to exist on the soft mud of which the bottom is composed over the greater part of the main area. At the southern end it lives only on rocky or stony ground and in the outer channel on a foreshore of muddy sand or sand. The species appears to be wholly absent from Barkul Point and Patsahanipur. The shores in these localities seem as suitable as at the southern end of the lake, but gastropod shells of any size do not occur.

In the main area very young specimens are to be found in shells of *Potamides fluviatilis*, while the larger individuals inhabit *Thais carinifera*. In the outer channel adults make use of *Telescopium fuscum*, while young examples are found in *Potamides*, *Natica* and *Nassa labecula*.

C. padavensis is to be found in the lake at all seasons of the year and occurs in water that is fresh, brackish, or as salt as that of the open sea in the vicinity. Oviparous females were obtained in March, both in the main area and in the outer channel, in water of specific gravity varying from 1.010 to 1.0265. Young specimens belonging to this genus are extremely scarce in the main area.

The species has a wide Indo-Pacific distribution, extending from the western coasts of India to Australia and New Caledonia.

Clibanarius longitarsis (de Haan).

1887. *Clibanarius longitarsis*, de Man, *Arch. f. Naturgesch.*, LIII, i, p. 441.

1915. *Clibanarius longitarsis*, Henderson, *Rec. Ind. Mus.*, XI, p. 25.

Henderson notes that this species, which is not included in Alcock's Catalogue of the hermit-crabs in the Indian Museum, is the commonest brackish-water Pagurid on the Coromandel coast. It is apparently scarce in the Chilka Lake and is almost certainly absent from the Gangetic delta.

The two specimens in our collection were found in company with *C. olivaceus*, crawling on submerged stones at the sides of the landing stage on Barkuda I. They were obtained in September 1914, when the water was very slightly brackish (sp. gr. 1.0065) living in shells of *Thais carinifera*. The species probably occurs at the southern end of the lake throughout the year in water of specific gravity varying from 1.006 to 1.015.

The specimens are both very small; the length of the carapace in the larger is only 11 mm., whereas in an individual recently obtained by Dr. Annandale in the Ennur backwater near Madras it is fully 30 mm.

C. longitarsis is known to have a distribution extending from E. Africa to Japan.

Clibanarius olivaceus, Henderson.

1915. *Clibanarius olivaceus*, Henderson, *Rec. Ind. Mus.*, XI, p. 26.

This species, described by Dr. Henderson from material obtained in the Chilka Lake and readily distinguished from the two preceding forms by the absence of the conspicuous stripes on the second and third legs, is represented in our collection by seven specimens.

They were all obtained at the south end of the lake: on the rocks at the base of Ganta Sila in February 1914, in water of specific gravity 1.010, and in September of the same year, in water of specific gravity 1.0065 on the landing stage at Barkuda I. At the former locality they were found in company with *C. padavensis*, at the latter with *C. longitarsis*, in both cases inhabiting shells of *Thais carinifera*.

Henderson also records specimens from the Adyar River and, in January 1915, Dr. Annandale obtained a single individual in the Ennur backwater, both localities being situated near Madras.

Genus DIOGENES, Dana.**Diogenes avarus**, Heller.

1915. *Diogenes avarus*, Henderson, *Rec. Ind. Mus.*, XI, p. 28.

This species is very abundant in the outer channel of the Chilka Lake and in the salt-water season penetrates to Nalbano. It is not a permanent inhabitant of the main area.

Specimens were found in shells of *Potamides* and *Nassa* and were particularly abundant in the outer channel in September, living in water that was quite fresh: every time the D-net was hauled over the clean sandy ground opposite Manikpatna hundreds of examples were caught. Ovigerous females were found only in March, in water as salt as that of the Bay of Bengal in the vicinity of the lake-mouth. The hydroid *Clavactinia gallensis* was only found on shells occupied by this species.

Nobili¹ considers *D. avarus* a synonym of *D. pugillator* (Roux) and *D. varians* (Costa), the former name having priority. The species, as recognised by Alcock, has a distribution reaching from E. Africa to the Torres Straits and, if Nobili's synonymy be correct, has a much wider range, extending to the Mediterranean.

Family COENOBITIDAE.**Genus COENOBITA**, Latreille.

With one exception all the specimens of this genus in our collection are very small and it is improbable that either of the species we obtained ever breeds in the lake. Examples of both forms were found in shells of *Natica*, a gastropod that does not occur in a living condition in any part of the lake-system. We regard the species as casual visitors rather than as permanent inhabitants.

¹ Nobili, *Ann. Sci. nat., Zool.* (9), IV, p. 119 (1906)

Coenobita rugosus, Milne-Edwards.

1915. *Coenobita rugosus*, Henderson, *Rec. Ind. Mus.*, XI, p. 29.

Two very young specimens were obtained in the outer channel between Manikpatna and the mouth of the lake. They were found crawling on the sandy shore of the outer bar in company with *C. cavipes*, and were living in shells of *Natica*.

At the time when they were obtained the water in the outer channel was fresh; but alterations in salinity must be of very little consequence to species of *Coenobita*, for they are typical land-hermits and live for the most part above water-level.

The geographical range of the species, according to Alcock, is Tropical West Africa: Red Sea littoral and East Africa, through the Indo-pacific to Vancouver, Lower California and Coquimbo.

Coenobita cavipes, Stimpson.

1915. *Coenobita cavipes*, Henderson, *Rec. Ind. Mus.*, XI, p. 29.

Small examples of this species were common at all seasons in the outer channel, both when the water was fresh and when it was salt. When the water is at its lowest, specimens may be found under the dry felted coating of algae which is exposed on the shores of the backwaters and among the islands. On the clean sand near the mouth of the lake the species is met with either walking in the open or sheltering in the burrows of *Ocypoda* and under drift wood.

A single large individual, with carapace 27 mm. in length, was obtained in December inhabiting a shell of *Ampullaria*. This gastropod is common in fresh water in the neighbourhood, but does not occur in the lake itself. The smaller specimens were living in shells of *Nassa*, *Potamides* and *Natica*.

Coenobita cavipes has a wide Indo-pacific distribution extending from E. Africa to the Loo Choo Is.

Tribe THALASSINIDEA.

Family CALLIANASSIDAE.

Subfamily CALLIANASSINAE.

Genus CALLIANASSA, Leach.

1903. *Callianassa*, Borradaile, *Ann. Mag. Nat. Hist.* (7), XII, p. 544.

The single member of this genus found in the Chilka Lake is identified with a form described by A. Milne-Edwards from a claw obtained in a sub-fossil condition in Siam. The species is closely allied to one found on the west coast of Africa, which appears triennially in the rivers in great numbers.

Callianassa (Callichirus) maxima, A. Milne-Edwards.

(Plate XIII, figs. 1-5.)

1870. *Callianassa maxima*, A. Milne-Edwards, *Nouv. Arch. Mus. Paris*, VI, p. 97.

The rostrum is sharply pointed, without lateral teeth, and is short, reaching barely to one-third the length of the eyes. There is no tooth on the frontal margin of the carapace between the eyes and the antennal peduncles (pl. xiii, fig. 1).

The eyes are subquadrilateral in dorsal view with their inner distal angles produced to a bluntly pointed process and their anterior margins oblique and concave. The inner margins are almost contiguous; they are straight and parallel with the outer margins. In the middle of the distal half there is a small round patch of black retinal pigment. The apices of the eyes reach a little beyond the articulation between the first and second antennular segments. The latter segment is stout, scarcely twice as long as broad. The third segment is more slender, but compared with some other species of the genus is comparatively short, less than one and a half times the length of the second. The distal extremity of the third segment reaches about to the middle of the terminal segment of the antennal peduncle. The antennal flagellum is apparently incomplete in the specimen described; it is, however, considerably longer than the subequal flagella of the antennules and is fully one and a half times the length of its peduncle.

The form of the outer maxillipede is shown in text-fig 21*e*. The ischium, merus and propodus are extremely broad and on the inner face of the first of these segments there is a longitudinal row of small granules commencing close to the articulation with the basis.

The first legs are very unequal. In the larger—the right in the specimen described (pl. XIII, figs. 2, 3)—the ischium is slender, but considerably expanded towards its distal end. The inferior edge is finely but irregularly tuberculate, the tubercles sometimes taking the form of small spinules; on the outer surface in the proximal two-thirds there is a sharply defined crenulate carina. Between this carina and the lower margin, the surface is covered with close-set granules that extend nearly to the ischio-meral joint. The merus is a trifle longer than the ischium and is rather more than two and a third times as long as broad. In form it is trigonal, the outer surface being traversed longitudinally by a conspicuous ridge, smooth distally, but crenulate at its proximal end. The upper border is finely crenulate in its basal half; otherwise the surface above the median ridge is quite smooth. Below it the surface is covered with tubercles, which are larger towards the proximal end, and near the inferior margin there is an oblique granular crest. The inferior margin is granular and setose and near the ischial articulation is produced to a large acute tooth. On its inner face the merus bears two conspicuous grooves that run close to and parallel with, the upper and lower borders; the surface is granular at the proximal end, otherwise quite smooth.

The carpus of the same limb is one-third broader than long; its length is about two-thirds that of the merus. The outer surface is smooth and evenly convex. The posterior margin below the mero-carpal joint is setose and a little uneven and the infero-distal angle bears a few spinules at its apex. On the inner surface the upper limit of the excavation into which the merus fits is defined by a strongly granular ridge and there are also scattered tubercles near the sharp crest that forms the upper margin and near the inferior angle. The distal margin, next the propodus, is finely crenulate internally; externally it is smooth.

The palm of the chela, measured along its upper margin, is one quarter longer than the carpus and is equal in breadth with that segment; it is rather more than

two-thirds the length of the dactylus. The upper margin of the palm, in its basal two-thirds only, bears a sharp ridge that is obscurely notched. The outer surface of the palm is evenly convex and the whole of its middle part is covered with granules which increase in size distally. Close to the gape of the fingers there is a cluster of large spinules and at the proximal end of a smooth blunt ridge that extends the entire length of the fixed finger there is a short row of rounded tubercles. On the inferior edge of the palm there is a series of close-set spinules. The inner face of the palm is covered with granules larger than those on the external surface and there are a few tubercles near the gape of the fingers. The inner edge of the fixed finger is without teeth and is feebly crenulate at the proximal end. In the gape at the base of the dactylar articulation is a blunt lobe serrated at the distal end. When the claw is closed the fingers meet only at the tip. The dactylus is curved and pointed at the apex and bears a few coarse and rather obscure tubercles on its upper margin near the base. On the inner edge there is a large bluntly trilobed tooth at the proximal end, a single large blunt tooth in the middle of the margin and a series of seven smaller teeth, also blunt, behind the tip. On both upper and lower margins of the palm and on the fingers are numerous tufts of coarse yellowish setae.

The smaller left leg of the first pair (text-fig. 21f) is totally different in form and bears no spinules or tubercles. The merus is about twice as long as broad and is longer than the ischium; the outer surface shows traces of a ridge. The carpus is about two and a half times as long as wide; the upper and lower margins are sharply crested and, throughout the greater part of their length, are strictly parallel. The chela is a little shorter than the carpus and about one and a half times the length of the merus. The fingers are about as long as the palm; they are obscurely serrate internally and bear tufts of coarse setae.

The form of the remaining pairs of legs is illustrated in text-figs. 21a-d. The propodus in the third pair bears a conspicuous lobe on its inferior margin; the fifth pair is perfectly chelate.

The second abdominal segment is the longest, equal to the fourth and fifth combined and a little longer than the sixth. There is a patch of soft hairs on the postero-lateral angles of the third and fourth and a similar patch in the middle of the fifth. The sixth somite is subcircular, narrower than the fifth; it is excavate on either side in the posterior third and in the middle of the distal margin there is a short longitudinal furrow (pl. xiii, fig. 5). The first two abdominal appendages are slender; the remaining three are broadly foliaceous.

The telson (pl. xiii, fig. 5) is subquadrilateral, little more than half the width of the sixth somite and one quarter broader than long. The lateral margins are gently rounded and the posterior margin slightly convex with a tuft of long setae on either side. In the middle of the upper surface there is a smooth hemispherical swelling, bearing tufts of setae, and behind this swelling are three conspicuous dimples, the middle one larger than the two lateral.

The uropods are much longer than the telson. The inner is triangular in shape,

the outer ovoid, with a small bilobed tubercle against which the endopod is folded when the tail-fan is closed.

The above description is taken from an individual, nearly 80 mm. in total length, that was obtained by purchase many years ago at Madras. The propodus of the larger first leg in this specimen is 23 mm. in length.

The material obtained in the Chilka Lake consists only of a solitary large leg belonging to the first pair and of two small and immature individuals.

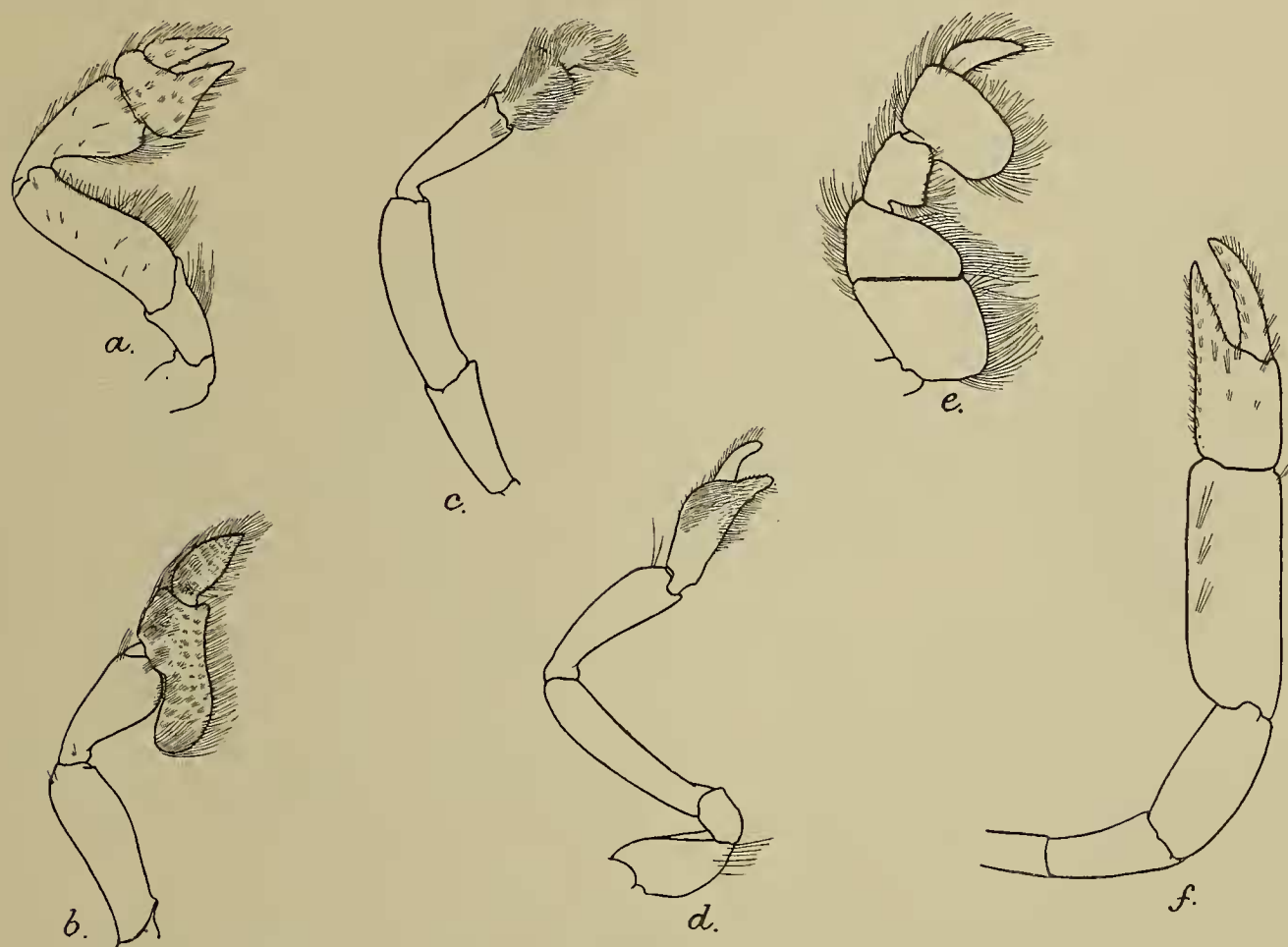


FIG. 21.—*Callianassa (Callichirus) maxima*, A. M.-Edw.

- | | |
|---------------------|------------------------------------|
| a. Second pereopod. | d. Fifth pereopod. |
| b. Third pereopod. | e. Third maxillipede. |
| c. Fourth pereopod. | f. Smaller pereopod of first pair. |

The large leg bears a close resemblance to that of the complete individual from Madras (pl. xiii, fig. 4) but the lower border of the merus is armed with large irregular spinules (the proximal one of the series taking the form of a bilobed tubercle); the tubercles on the upper edge of the dactylus, near the base, are more prominent and the surface granulation is in most places more scanty. The last feature is doubtless correlated with age; the chela found in the Chilka Lake evidently belonged to a smaller specimen than that from Madras, the propodus being only 17 mm in length. The teeth on the inner edge of the dactylus are closely similar to those of the Madras specimen, but the series near the tip consists only of four teeth.

The largest of the two immature individuals is only 15 mm. in total length. The eyestalks have the same form as in the adults, but are rather more convex dorsally and the patch of retinal pigment is proportionately much larger. The segments of the antennal and antennular peduncles are of proportions similar to those of adults and this is also true of the first legs, except that, in the larger of the two, the carpus is rather longer in comparison with its breadth. None the less there is still a very great difference in this respect between the right and left carpus of this pair. The fingers of the large chela, which is little more than 3 mm. in length, show only faint indications of teeth and the surface of the entire limb is smooth and polished. The telson is similar to that of the adult, but the sculpture is less defined.

Callianassa maxima was described by A. Milne-Edwards from a single chela of gigantic dimensions obtained in a sub-fossil condition in Siam, many miles from the sea. This chela is 60 mm. in length, nearly three times the size of that of the individual from Madras. The granulation as described and figured in the sub-fossil chela is much more pronounced than in any of the living examples obtained on the Indian coast; but this, I believe, is largely a matter of age. The armature of the inner margin of the dactylus is apparently very characteristic and in this respect there is the closest possible resemblance between the Indian specimens and that from Siam.

That this species, hitherto known only as a fossil, should now be discovered in a living state need occasion no great surprise; A. Milne-Edwards at the end of his description remarks¹ "Peut-être découvrira-t-on un jour que cette espèce vit encore sur les côtes de Siam, car il est probable que les alluvions dans lesquelles elle a été trouvée sont relativement peu anciennes et analogues à celles qui existent sur certains rivages des mers de Chine et de l'océan Indien, ou on a rencontré à l'état fossile des espèces de crustacés qui aujourd'hui vivent encore dans les mêmes mers, tels que la *Scylla serrata* et l'*Ixa canaliculata*, à côté d'espèces inconnues aujourd'hui, telles que le *Macrophthalmus Latreillei*." Since this passage was written living examples of the last named species have been found.

Callianassa maxima is apparently allied to *C. turnerana*, White², but the latter species is readily distinguished by the armature of the merus and dactylus of the larger chelipede, by the absence of surface granulation on this limb, by the much shorter carpus of the smaller chelipede, by the trispinous rostrum and by the form of the telson. *C. turnerana*, with which *C. diademata*, Ortmann, is apparently synonymous³, is found in the Cameroons in W. Africa, in the rivers of which it is sometimes found in prodigious numbers. According to Vanhöffen⁴, the species is restricted to brackish water and the swarms appear at intervals of approximately three years, a period which he regards as that of the normal life-cycle.

The history of the Madras specimen is unknown; it probably came from one of the backwaters in the vicinity of that city. Of the Chilka specimens, the solitary large limb (which contains muscular tissue and is not merely a dessicated fragment) was

¹ *loc. cit.*, p. 98.

² White, *Proc. Zool. Soc., London*, 1861, p. 42, pl. vi.

³ Lenz, *Sitz-ber. Ges. naturf. Freunde, Berlin*, 1911, p. 316.

⁴ Vanhöffen, *ibid.*, 1911, p. 105.

obtained in March on the shores of Nalbano I. in water of specific gravity 1.008. The two immature individuals were found in September in water that was almost or quite fresh. Both were taken in soft muddy sand; one at Nalbano I. and one near Barhampur I. in the outer channel. The species apparently lives only in mud mixed with a considerable proportion of sand. It is doubtless a permanent inhabitant of the lake, able to exist in water of specific gravity varying from 1.000 to 1.0265.

The precise locality of the subfossil Siamese specimen is not stated. It was found while cutting a canal at a great distance from the sea.

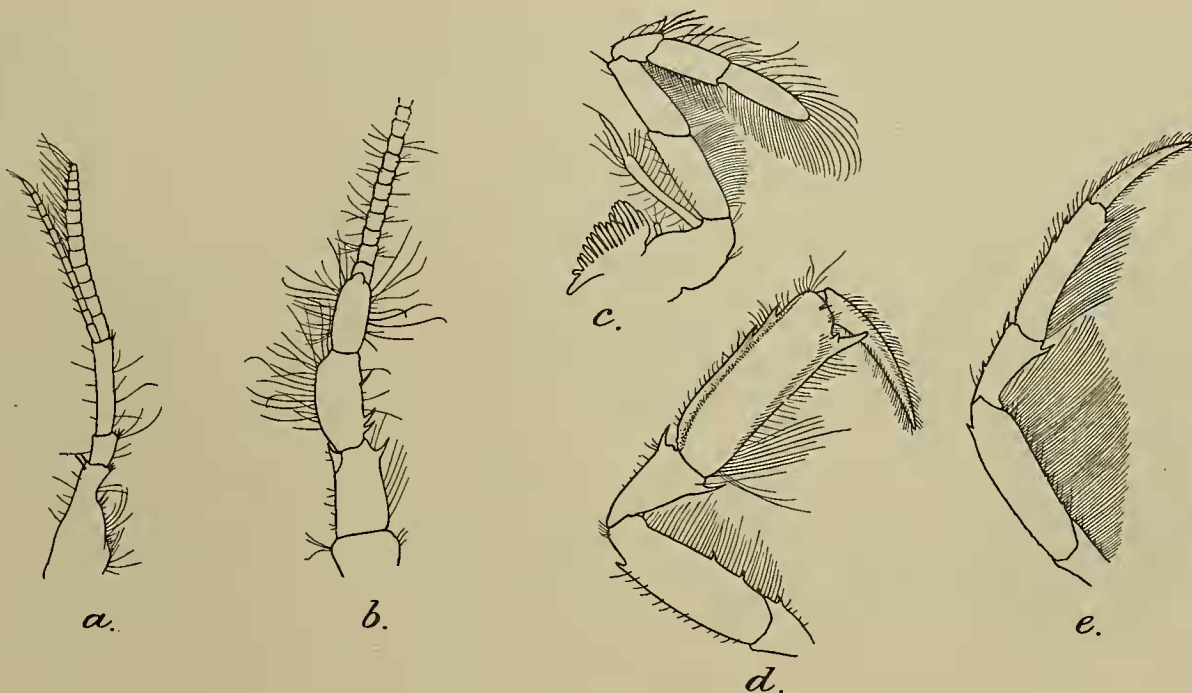


FIG. 22.—*Upogebia (Upogebia) heterocheir*, sp. nov.

- | | |
|-------------------------------------|-------------------------------|
| a. Antennule, dorsal view. | c. Third maxillipede. |
| b. Antennal peduncle, lateral view. | d. First peraeopod of male. |
| | e. First peraeopod of female. |

Subfamily UPOGEBIINAE.

Genus UPOGEBIA, Leach.

1903. *Upogebia*, Borradaile, *Ann. Mag. Nat. Hist.* (7), XII, p. 542.

The single species of this genus found in the Chilka Lake is remarkable for the differences that exist between the sexes in the form of the first pair of legs. In the male these limbs are sub-chelate, whereas in the female they are monodactylous.

Upogebia (Upogebia) heterocheir, sp. nov.

(Plate XIII, figs. 6, 7.)

The rostrum is slightly inclined downwards and reaches beyond the end of the eyes by nearly half its length. In dorsal view it is narrow with a rather sharply rounded apex which is not provided with teeth or spinules (pl. xiii, fig. 6). The

lateral tooth on each side is long and sharp and, when seen from above, is separated from the margin of the rostrum proper by a V-shaped incision which is continued backwards in the form of a deep furrow almost to the cervical groove. External to this furrow and parallel with it is a strong ridge which extends to the tip of the lateral tooth. These ridges and the upper surface of the rostrum are covered with fine hair, but are otherwise smooth and without trace of granules or tubercles.

The carapace behind the deeply cut cervical groove is smooth and polished. On the frontal margin behind the eye there is a small and inconspicuous tubercle, sometimes almost obsolete, and where the cervical groove is cut by the linea thalassinica there is a stout hepatic spine.

The antennular peduncle extends but little beyond the rostrum. The third segment is very slender and fully three times the length of the second (text-fig. 22a); the flagella are subequal, about three-quarter the length of the peduncle. The antennal peduncle is composed of only four distinct segments (text-fig. 22b). At the distal end of the second segment there is a large ventral spine and, not infrequently, a small dorsal spinule. Superiorly, between the second and third segments, is a small articulated piece consisting of a single tooth with a broad base; this is apparently a rudiment of the antennal scale and not a vestige of the suppressed segment. The third segment bears one, less commonly two teeth on its ventral margin near the proximal end.

On the third maxillipedes (text-fig. 22c) there is a rudimentary epipod.

The first legs are subchelate in the male (text-fig. 22d), monodactylous in the female (text-fig. 22e). In both sexes they reach beyond the rostrum by the whole of the last three segments. There is a spinule on the lower margin of the ischium and

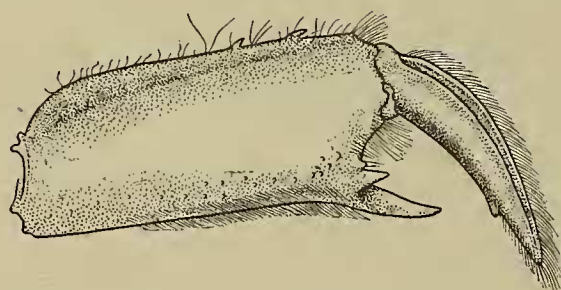


FIG. 23.—*Upogebia* (*Upogebia*) *heterocheir*,
sp. nov.

Last two segments of the first pereopod of a
large male; from a cast skin.

a series of from 2 to 6 on the same edge of the merus. The upper border of the latter segment is unarmed except for one (rarely two) subterminal spines. The carpus is much widened distally and is little more than half the length of the merus. It bears three or four spines. Three of these are placed at the distal end, one above, one below and one on the inner side; the fourth, which is rarely absent¹, is smaller than the others and is situated on the upper margin at about the middle

of its length. The propodus is longer than the merus and, on its upper edge, bears from two to four spines. In adult males it is from two and a half to three times as long as broad, whereas in females, in which the whole limb is more slender, it is fully four times as long as broad. In the latter sex there is only a comparatively small subterminal spine on the under margin; in the male it is much enlarged forming, with the dactylus, a subchela. This tooth or fixed finger of the male is less than half the

¹ It is absent in text-fig. 22d.

length of the dactylus; the margin opposed to the dactylus is entire, but externally near the base it bears a large blunt spine or tubercle. Externally the propodus is longitudinally grooved near the upper border, while near the lower border is a row of setae. The inner surface is smooth, but near the upper border is traversed longitudinally by a row of pits from which setae arise. The dactylus is ridged dorsally throughout its length; there are no teeth or serrations on the lower edge. In the chela of a very large male, represented merely by a cast skin (text-fig. 23), there are a few scattered tubercles on the outer surface of the palm near its inferior edge; the dactylus bears two strong ridges on its upper surface and a blunt tooth in the distal half of its lower margin.

There are no spines on the basal segments of the last four legs. In the second pair (text-fig. 24*a*) the merus bears two or three spines, one, which is subterminal, on

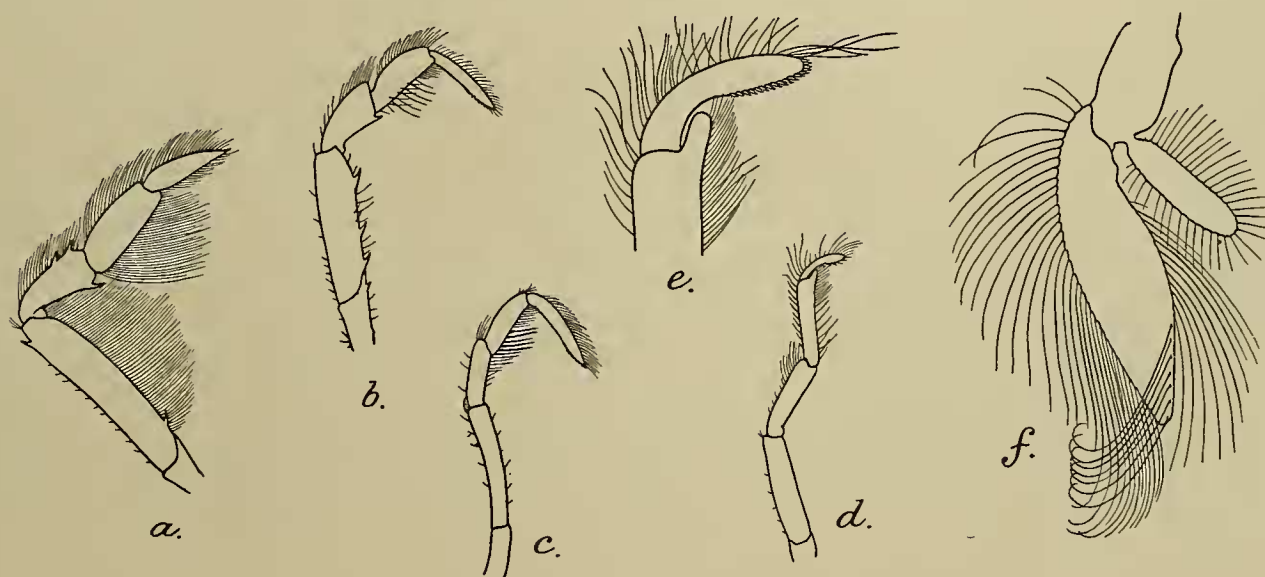


FIG. 24. --*Upogebia* (*Upogebia*) *heterocheir*, sp. nov.

a. Second peraeopod of male.

b. Third peraeopod of male.

c. Fourth peraeopod of male.

d. Fifth peraeopod of male.

e. Terminal joint of same, further enlarged.

f. Second pleopod of male.

its upper edge and one or two below, one proximal and one near the middle, the latter sometimes absent. The carpus bears three spines; two placed close together in the distal half of its upper border and one situated beneath them, on the lower border. In the third legs (text-fig. 24*b*) there are from 3 to 6 spines on the lower margin of the merus and one in the same position on the carpus. In the fifth the propodus projects a little beyond the articulation of the dactylus; but the limb could scarcely be termed subchelate (text-figs. 24*d*, *e*).

The branchial formula consists of ten arthrobranchs on each side, arranged in pairs at the base of the third maxillipedes and first four legs. There are no branchiae above the fifth legs.

Except for fine scattered setae, most conspicuous on the lateral margins, the abdominal somites are smooth and polished. The sixth somite (pl. xiii, fig. 7) is the longest, almost one and a half times the length of the second. In dorsal view the

sides of the fifth somite are strongly convex, while those of the sixth are concave in the anterior three-quarters of their length. The sixth segment is widest posteriorly.

The telson is a little broader than long (pl. xiii, fig. 7); its lateral margins are somewhat convergent and the apex is noticeably emarginate. On the upper surface there is an obscure \cap -shaped ridge, the extremities of the \cap being directed towards the postero-lateral angles. In the middle line there is an obscure sulcus and on either side, external to the \cap -shaped ridge, there is a well-marked longitudinal groove. On the dorsal surface of both inner and outer uropods there are two blunt ridges.

A large male is only 23 mm. in length.

Upogebia heterocheir appears to differ from all known species of the genus in the remarkable sexual differences in the first pair of legs and, apart from this feature, is distinguished by the position of the spines on the leg-segments and other characters. In the Chilka Lake it is probably abundant; but, owing to its burrowing habits, it was difficult to obtain any number of specimens. It is, however, represented in our collection by thirty-two individuals, mostly small, and a number of cast skins.

The species is a permanent inhabitant of the lake; it was found both in the main area and in the outer channel at all seasons of the year, in water of specific gravity varying from 1.000 to 1.0265. It seems to prefer a bottom composed of mud with a considerable admixture of sand and it was on ground of this character near Nalbano and off Barhampur I. that the majority of our specimens were obtained. In several localities cast skins were taken in abundance and it is evident that the act of exuviation is performed simultaneously by a large number of individuals. Cast skins were found in February and in September; it is probable, therefore, that there are at least two moulting periods in the course of the year.

Ovigerous females were found only in the months of November and December, in water of specific gravity varying from 1.001 to 1.0125. The eggs are large, about 0.74 mm. in longer diameter.

The type specimens are registered under no. 9304/10.

DECAPODA NATANTIA.

Tribe CARIDEA.

Family CRANGONIDAE.

Genus PONTOPHILUS, Leach.

1912. *Pontophilus*, Kemp, *Rec. Ind. Mus.*, VI, p. 8.

In the paper quoted above I have endeavoured to show that the genera *Pontophilus*, Leach, and *Philocheras*, Stebbing, must be united, the former name having priority. Though such extreme forms as *spinosus* (Leach) and *echinulatus* (M. Sars) are readily distinguished by several features which at first sight seem of generic value, there exist species almost precisely intermediate in character. Any division into two genera must, I believe, be of an arbitrary nature and can only tend to obscure the affinities of the species comprised in the series.

In the species here described the lateral process of the antennular peduncle is distally rounded, there is no exopod on the first peraeopods, the second peraeopods are comparatively long and reach to the carpus of those of the first pair and there is no appendix interna on the pleopods. In these particulars the species agrees with *echinulatus* (M. Sars) and with *bispinosus* (Westwood, = *nanus*, Kröyer), the latter of which may be taken as the type of Stebbing's *Philocheras*.¹

***Pontophilus hendersoni*, sp. nov.**

(Plate XIII, fig. 8.)

In general appearance this species bears a close resemblance to *P. bispinosus* (Westwood).

The rostrum is broad, parallel-sided, and bluntly rounded apically; it is deeply channelled longitudinally, the margin forming a raised rim which is contained laterally round the orbits.

In dorsal view, the carapace (including the rostrum) is a little longer than broad. Situated in the mid-dorsal line near the rostral base there is small, sharp, forwardly directed spine, which does not, as in many other species, form the termination of a median carina. On either side behind the middle of the orbit, there is in the anterior third of the carapace a blunt longitudinal ridge, which posteriorly sinks imperceptibly to the general level of the carapace, but anteriorly terminates abruptly in the same latitude as the median spine. A feeble groove defines the upper limit of the branchial chamber and is continued forwards as a shallow depression towards the base of the antennae. This depression is bounded beneath by a blunt ridge which is co-terminous anteriorly with the acute antennal spine. There is no hepatic spine. The branchiostegal spine is large and sharp; it is flanked by a short carina and extends far beyond the level of the rostrum (pl. xiii, fig. 8).

The thoracic sterna are broad posteriorly. The last four are furnished with blunt carinae in the middle, each of which terminates anteriorly in a short spine. In front of them a long and sharp spine projects forwards between the bases of the first legs.

The eyes are deeply pigmented; their shape, including the stalks, is almost globular. The basal segment of the antennular peduncle does not bear spines either ventrally or at its outer distal end; its lateral process is subquadrate in outline and is not pointed anteriorly; the second segment is considerably longer than the third; the greatly swollen outer flagellum of the male is about one and a half times the length of the peduncle (text-fig. 25*b*). The antennal scale is about two and a quarter times as long as broad (text-fig. 25*a*). The outer margin is almost straight and terminates in a large spine which reaches as far forwards as the rather sharply angled apex of the lamella.

The ultimate segment of the outer maxillipede is broadly rounded apically and scarcely reaches beyond the distal end of the scale.

¹ Stebbing, *Marine Invest. S. Africa*, I, p. 48 (1902).

The first legs (text-fig. 25c) reach almost as far forwards as the outer maxillipedes and do not possess exopods. The merus bears externally a small procurved tooth a little behind its distal end. The carpus is short and apparently does not bear spines. The hand is very broad; the "thumb" of the subchela is extremely large and the maximum breadth, "thumb" included, is considerably more than half the total length. A peculiar feature of the thumb-tooth is that its apex is bifid, composed of two closely adjacent spines (text-fig. 25c'). There are coarse serrated hairs at the inner angle of the carpus and on the adjacent margin of the propodus. Finer hairs occur on the cutting edge of the latter segment and on the margins of the merus.

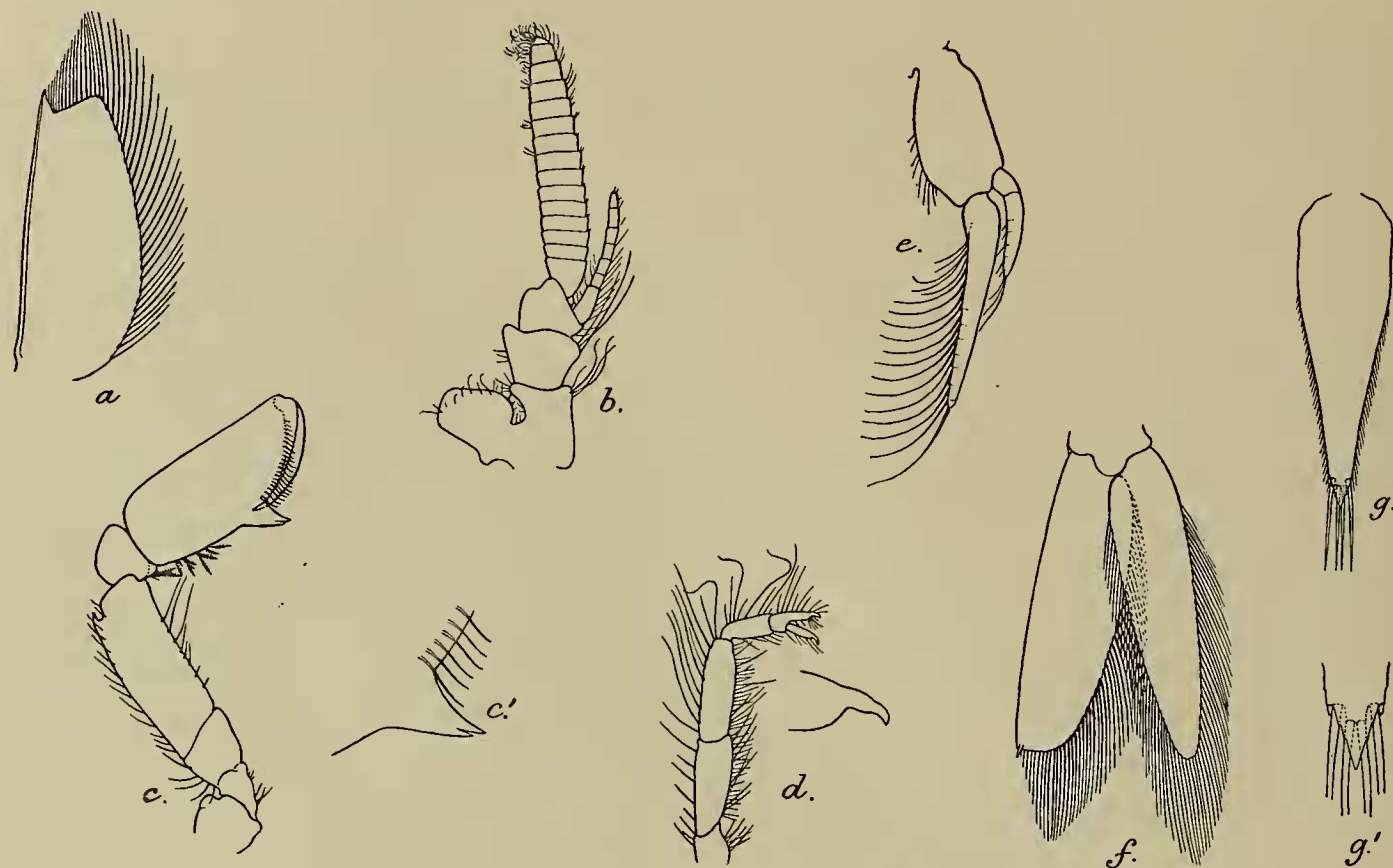


FIG. 25.—*Pontophilus hendersoni*, sp. nov.

- | | |
|--|--|
| a. Antennal scale. | d. Second peraeopod, with apex of fixed finger further enlarged. |
| b. Antennule of male. | e. Second pleopod of male. |
| c. First peraeopod. c'. The 'thumb' of the sub-chela further enlarged. | f. Outer and inner uropods. |
| g. Telson. g'. Apex further enlarged. | |

The second legs (text-fig. 25d) reach about to the end of the carpus of the first pair and are clothed with fine hairs. The merus and ischium are broad and about equal in length; the carpus is little more than half as long, but is as long as and stouter than the chela. The latter is weakly constructed; the fingers are nearly twice the length of the palm and the inner edges meet throughout their length when the claw is closed; each finger is noticeably constricted at the apex and does not bear a distinct claw.

The third legs are very slender and reach to the apex of the antennal scale. The merus is one and a third times the length of the ischium and is a little shorter than

the carpus. The propodus and dactylus are partially fused; taken together, their length is slightly shorter than that of the merus. Close to the apex of the dactylus there is a small tuft of setae.

The fourth and fifth legs are similar, stouter than those of the third pair. In the fourth pair, which reaches a little beyond the apex of the antennal scale, the merus is the longest segment, almost twice the length of the dactylus. The carpus is a little more than two thirds the length of the merus and is a little shorter than the propodus and a little longer than the ischium. Except for a few hairs on the latter segment and at the base of the merus the segments are naked.

There are no longitudinal carinae on any of the abdominal somites and, except for a feeble transverse groove near their posterior margins, the first five abdominal somites are unsculptured; on the dorsal surface of the third somite, however, not far from the distal margin, is a small tubercle which is a very conspicuous feature in lateral view. The sixth somite is about one and a half times the length of the fifth and is only a trifle shorter than the telson.

The inner branch of the pleopods is in all cases very short and does not bear an appendix interna. Judging from differences in the proportions of the outer antennular flagellum the majority of the specimens obtained are males; in no individual, however, have I been able to find a trace of the appendix masculina (text-fig. 25e).

The uropods (text-fig. 25f) are a little longer than the telson: the exopod is about three and a half times as long as wide. The telson (text-fig. 25g) is not sulcate above and is much narrowed distally: it has setose margins but no dorso-lateral spinules. The apex (*g'*) is very narrow and is formed by an acutely triangular plate bearing two pairs of fine plumose setae.¹ On either side at the base of this plate is a short and blunt spinule and between these spinules (underneath the plate) are two pairs of very large setae.

The largest specimen is only about 10 mm. in length; but is, I believe, fully adult.

The colouration of the species in life is very variable. As a rule there are two transverse bars of dark reddish-brown pigment, one in the anterior half of the carapace and another on the fourth abdominal somite. There are also on the dorsal surface several large black or dark brown chromatophores, the distribution of which is very irregular, and frequently a large white spot at the proximal end of the last abdominal somite. The margins of the abdominal pleura are umber brown; the upper edge of the first legs and the basal segments of the first four legs and last two swimmerets are dark.

Pontophilus hendersoni bears little resemblance to any other Indo-pacific species of the genus. Its nearest ally appears to be *Pontophilus bispinosus* (Westwood), a common European species; from this form, however, it is easily distinguished by the sculpture of the carapace and by numerous minor details.

The species is described from thirteen specimens found in March 1914, in the outer channel of the Chilka Lake. They were caught in nets hauled at a depth of

¹ Not shown in text-fig. 25g'.

1 or 2 feet over the hard sand near the mouth of the lake. At the time when they were obtained the water in the outer channel was as salt as that of the sea outside the lake. In September 1914, when it was quite fresh we searched carefully for the species in the same place, but were unable to discover any more specimens. The species appears to be only a casual visitor to the extreme outer parts of the lake during the salt-water season.

The type specimens bear the no. 8970/10 in the Museum register.

Family PALAEMONIDAE.

Borradaile in a short preliminary paper, recently published¹, has divided the Palaemonidae into four sub-families, the Desmocaridinae, Pontoniinae, Palaemoninae and Typhlocaridinae. The characters used in the separation of the first three of these subfamilies are, in the main, those to which Sollaud has already drawn attention. I am inclined to think that the arrangement suggested is not likely to be permanent; but the number of forms obtained in the Chilka Lake is so small that the occasion is not a suitable one for a discussion of the matter.

The Palaemonidae found in the lake comprise seven species belonging to the genera *Palaemon*, *Leander*, *Urocaris* and *Periclimenes*. The last two genera are represented by single species which are described as new; they are able to live in either fresh or salt water and to tolerate considerable periodic variations in salinity. Both species occur among weeds and *Urocaris* is one of the commonest and most widely distributed Crustacea in all parts of the lake: the *Periclimenes* is found only in the outer channel.

The single species of *Leander* and one of the Palaemons, *P. scabriculus*, must be regarded as casual visitors to the lake, the former from the sea, the latter from the ponds or rice fields.

Only females of *Palaemon malcolmsoni* and *P. lamarrei* have been found in the lake and our observations lead us to conclude that these species visit its waters only for breeding purposes. This is also the case with the remaining species of the genus, *P. rudis*, the males of which accompany the females at this period. Adults of these three forms do not live in water as salt as that of the Bay of Bengal; but the young of *P. rudis* were found in the outer channel at the salt-water season, while adults of *P. lamarrei* are able to tolerate a considerable degree of salinity. *P. malcolmsoni* was found only in fresh water.

Although the species of *Periclimenes* and *Urocaris* are here described as new, they also occur at other places on the east coast of India, the *Periclimenes* at the mouth of the Adyar river at Madras, the *Urocaris* in backwaters in the same neighbourhood and also in pure sea-water inside the coral reefs and in the shallows of the Gulf of Manaar. The *Urocaris* is a very close ally of a species found in the Gulf of California and on the Pacific Coast of Mexico.

¹ Borradaile, *Ann. Mag. Nat. Hist.* (8), XV, p. 206 (1915).

Genus **PALAEMON**, Fabricius.**Palaemon lamarrei**, Milne-Edwards.

1908. *Palaemon (Eupalaemon) lamarrei*, de Man, *Rec. Ind. Mus.*, II, p. 222, pl. xix, fig. 4.

This species is represented in our collection by numerous specimens found at Rambha in February and at Barkul in March 1914. All the larger examples are females and a great number bear eggs.

The measurements (in mm.) of four specimens are as follows¹:—

Sex.	Total length.	Length of carapace.	Length of chelipede.	Chelipede (2nd leg): length of				
				Ischium.	Merus.	Carpus.	Palm.	Dactylus.
♀	58	13.4	25.5	5.0	5.7	8.0	3.4	2.6
♀	54	12.4	22.6	4.5	5.1	7.1	2.6	2.1
♀	50	11.0	21.6	4.4	5.0	6.9	2.3	2.0
♀	44	9.6	19.0	4.1	4.3	6.0	1.9	1.7

It will be noticed that there is some difference between these figures and those given by de Man for younger specimens; the carpus, in particular, though still decidedly longer than the chela, is proportionately shorter.

The rostrum, in adult females, reaches only to the apex of the antennal scale, or a little beyond it. In other respects the specimens agree closely with de Man's description.

Henderson and Matthai have pointed out² that the eggs in this species are very large and by hatching experiments have succeeded in proving that development is direct and without metamorphosis. In the Chilka specimens eyed eggs average 1.5 mm. in length by 1.1 mm. in breadth, measurements which differ somewhat from those obtained by the above-mentioned authors from specimens found near Madras.

Palaemon lamarrei, originally described by Milne-Edwards from the coasts of Bengal, is common in the Gangetic Delta in fresh or slightly brackish water and, as noticed above, has been found near Madras. De Man (*loc. cit.*) has pointed out that

¹ In this table, and in the measurements given on succeeding pages, the total length is taken from the tip of the rostrum to the apex of the telson and the length of the carapace from the back of the orbit to the mid-dorsal point at its posterior end. The chelipede is measured from the basipodite (which forms a convenient point of application for a pair of callipers) to the tip of the chela. In the case of individual segments the measurements represent the greatest length of each segment. The instrument used in taking all measurements under 100 mm. is a pair of callipers fitted with a dial which gives direct readings to .1 mm.

² Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 301 (1910).

the records by Ortmann from Brazil and by de Haan from Japan are to be discredited.

In the Chilka Lake the species is not abundant, but was found in some numbers in February 1914, near Rambha, when the specific gravity of the water was 1.011. The specimens, however, were taken near the mouth of a small stream and in this locality the water was doubtless less salt than in other places in the vicinity. The examples obtained in March of the same year at Barkul were caught by fishermen.

The large number of ovigerous females in the collection, and the total absence of individuals which can be recognised as males, are facts which suggest that the species migrates from the fresh water in the neighbourhood to liberate its young in the lake.

Palaemon malcolmsoni, Milne-Edwards.

1910. *Palaemon malcolmsoni*, Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 83, pl. xv, figs. 2a-f.

Ten large ovigerous females of this species were obtained in September 1914, at Barkul, in company with numerous examples of *Palaemon rudis*.

The rostrum, in its shape and dentition, agrees precisely with the description given by Henderson and Matthai. The measurements of the specimens (in mm.) are as follows:—

Number.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede.	Larger chelipede : length of					Proportionate length of segments of larger chelipede to total length of chelipede (100):				
					Ischium.	Merus.	Carpus.	Palm.	Dactylus.	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
1	136	37.9	108	108	19.9	21.4	27.5	20.3	16.9	18.2	19.6	25.2	18.6	15.5
2	136	36.5	101	104	18.8	20.4	25.9	20.0	16.7	18.0	19.6	24.9	19.2	16.0
3	125	30.5	97	98	17.1	18.4	22.2	19.7	16.5	17.4	18.8	22.6	20.1	16.8
4	122	35.3	98	93	17.5	19.5	22.8	20.5	14.9	17.8	19.9	23.3	20.9	15.2
5 ¹	122	29.9	88	92	15.9	18.7	20.5	20.6	14.1	17.3	20.4	22.3	22.5	15.4
6	119	32.4	81	86	15.8	16.1	19.6	16.6	13.2	18.3	18.7	22.7	19.3	15.3
7	116	31.7	84	84	15.3	16.8	20.4	15.4	12.2	18.2	20.0	24.3	18.3	14.5
8	116	29.4	77	78	14.4	15.2	18.8	15.2	11.1	18.4	19.5	24.1	19.5	14.2
9	105	27.5	73	78	14.0	14.6	17.8	16.0	11.9	17.9	18.7	22.8	20.5	15.2
10	107	28.8	72	77	13.0	15.2	18.3	15.1	10.2	16.9	19.8	23.8	19.6	13.6
Average ..										17.8	19.5	23.6	19.7	15.2

At the time of their capture the distinctions between these specimens and females of *Palaemon rudis* were not appreciated. The two forms may be distinguished by the following characters:—

¹ The palm in this specimen is quite abnormal in length and has been omitted in calculating the average proportionate length of the segment. The palm of the other chelipede in the same individual is of normal dimensions.

P. malcolmsoni, ♀.

Rostrum longer, reaching to or beyond apex of antennal scale; proximal margin of upper border markedly convex, apex a little upturned. Dorsal teeth aggregated on proximal part; teeth on distal part few, either confined to apex or very widely separated. Three dorsal teeth on carapace.

Inner and outer margins of antennal scale sub-parallel.

Chela of first peraeopods with fingers decidedly shorter than palm. Palm with large patch of coarse setae on its infero-internal aspect. Fingers gape at base when claw is closed.

Second peraeopods with fine spinules arranged in longitudinal rows. Dactylus in very old females densely covered with hairs. Carpus shorter than palm + half the length of fingers.

P. rudis, ♀.

Rostrum shorter, reaching at most to apex of antennal scale. Upper margin straight or very slightly convex, apex not upturned. Dorsal teeth almost evenly spaced throughout length of rostrum. Two dorsal teeth on carapace.

Inner and outer margins of antennal scale anteriorly convergent.

Chela of first peraeopods with fingers equal in length to palm. Palm with small patch of coarse setae on its infero-internal aspect. Fingers do not gape at base when claw is closed.

Second peraeopods practically glabrous. Carpus longer than palm + half the length of fingers.

A series of very much smaller specimens found at Satpara in March 1914 may also belong to this species, though they differ markedly from the larger individuals noticed above. The series comprise several ovigerous females and a few males in which the appendix masculina is to all appearances fully formed; the largest specimen, an egg-bearing female, is 58.5 mm. in total length. The great difference in size between this individual and those found at Barkul is not, of itself, sufficient to disprove the specific identity of the two series of specimens. Henderson and Matthai have pointed out that species of *Palaemon* may be sexually mature when extremely small in size and that males may possess well-developed testes containing free spermatozoa long before their chelipedes have reached the dimensions characteristic of large members of their sex. There is reason to believe that a precocious sexual development of this nature occurs in the case of *Palaemon rudis* in the Chilka Lake (*vide infra*).

In the specimens from Satpara the rostrum in both sexes is much more strongly upturned distally and the crest on the dorsal margin is less elevated than in the large females found at Barkul. The teeth are also rather larger proportionately and those on the upper margin are more evenly distributed, though those situated behind the one or two placed at the apex are in most cases separated by distinctly wider intervals than those near the rostral base. There are 11 or 12 dorsal and 5 or 6 ventral teeth; of the former three are situated on the carapace behind the level of the orbit.

The antennal scale is distinctly narrowed towards its distal end, thus differing from that of the larger specimens; in the chela of the first peraeopods there is a closer resemblance, but the fingers do not gape at the base when the claw is closed.

The length of the second peraeopods, in both males and females, is only about 70% of the total length and the proportionate length of the ischium, merus, carpus,

palm and dactylus are approximately as 18, $18\frac{1}{3}$, 26, 17 and 15. The ischium, as Henderson and Matthai have shown, is as a rule proportionately longer in young (but not necessarily non-adult) Palaemonidae, than in full grown individuals. If allowance be made for this point it will be seen that the proportions are not strikingly different from those of large females. The segments bear small spinules precisely as in the large specimens.

A notable difference exists in the armature of the telson tip. In the Satpara specimens the inner pair of terminal spinules project far beyond the apex, whereas in large *P. malcolmsoni* they fall considerably short of it.

Whether the series from Satpara is correctly referred to *P. malcolmsoni* or not—and I am extremely doubtful of the accuracy of the determination—it is clear that it does not include any fully developed males and is therefore inadequate for a complete specific description. If the specimens are not young *P. malcolmsoni* they certainly cannot be identified with any other form known from Indian waters.

It will be noticed that in the specimens from Pondicherry, referred by Nobili to Heller's *P. danae*¹ and regarded by Henderson and Matthai as young *P. malcolmsoni*, there are fewer teeth on the lower border of the rostrum and no spinules on the segments of the second peraeopods.

The carapace of living examples from Satpara was dotted with chromatophores which formed definite spots laterally and an indefinite longitudinal dorsal streak. There was a conspicuous dorsal patch of white in the posterior part of the third abdominal somite and the legs were banded with maroon, with all the joints orange yellow and the dactyli of the last three pairs clear red. The chela of the second peraeopods and caudal fin were mottled with maroon and yellow pigment and the edges of the abdominal pleura were brown.

In the case of the large females from Barkul the legs were not banded, but had a purplish tinge. The margins of the abdominal pleura were usually bordered with pure white, but those of the last two segments were in some cases brown. There was no white patch on the third abdominal somite. The eggs in both cases were of an olivaceous tint.

The large females from Barkul were obtained when the water was quite fresh. The fact that, among numerous specimens examined, no large males were to be found, suggests that the females, as with *P. lamarvei*, may migrate to the lake when their eggs are ready to hatch.

The specimens of doubtful identity, obtained at Satpara, were found in water as salt as that of the Bay of Bengal near the mouth of the lake.

Palaemon rudis, Heller.

1910. *Palaemon rudis*, Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 291, pl. xvii, figs. 5a—h.

Palaemon rudis is the commonest species of its genus in the Chilka Lake and is represented in our collection by a large number of specimens both young and adult.

¹ Nobili, *Boll. Mus. Torino*, XVIII, No. 452, p. 7 (1903).

The teeth on the rostrum are more variable in number than is indicated in the description given by Henderson and Matthai. On the upper margin there are from 9 to 12 (usually 10 or 11) and on the lower margin from 3 to 5 (usually 4). In all cases the three posterior dorsal teeth are situated on the carapace.

The measurements of a series of males are shown below. Of these specimens, nos. 1—16 are fully developed,—that is to say, they have assumed the characters typical of large individuals of their sex. The second peraeopods or chelipedes are usually unequal in length and the larger of the two is nearly equal to, or considerably longer than, the total length; the segments are clothed with a fine velvety pubescence and tubercles are present on the fingers on either side of the cutting edge. With these features a well marked colour distinction is correlated, the chelipedes being dark blue-grey with a pale dorsal stripe.

Number.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede.	Larger chelipede : length of					Proportionate length of segments of larger chelipede to total length of chelipede (100) :				
					Ischium.	Merus.	Carpus.	Palm.	Dactylus.	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
1	108	33.2	182	209	21.0	41.4	63.5	45.0	35.7	10.0	19.8	30.4	21.5	16.6
2	114	34.4	202	138	20.0	39.1	60.3	46.9	35.8	10.0	19.5	30.2	23.4	17.9
3	110	35.0	182	198	20.0	38.6	58.5	43.0	36.8	10.1	19.5	29.5	21.7	18.6
4	106	32.2	180	198	20.8	40.7	59.5	40.4	35.3	10.5	20.6	30.0	20.4	17.8
5	112	33.5	173	192	20.5	38.0	60.3	40.0	32.0	10.7	19.8	31.4	20.8	16.7
6	108	33.7	165	179	19.9	35.8	53.2	37.2	32.3	11.0	20.0	29.8	20.8	18.1
7	108	32.0	162	174	19.0	34.0	51.3	38.5	31.0	10.8	19.4	29.2	21.9	17.7
8	94	28.1	144	173	17.7	35.0	53.4	35.4	29.8	10.2	20.2	30.8	20.5	17.2
9	112	34.2	156	168	20.8	34.8	49.1	38.4	31.2	12.5	20.9	29.5	23.0	18.7
10	94	28.8		120	14.0	23.2	33.0	26.8	21.6	11.7	19.3	27.5	22.3	18.0
11	94	28.2	105	111	13.7	21.9	32.0	23.7	19.3	12.3	19.7	28.8	21.3	17.4
12	100	28.7	104	104	13.2	20.3	30.2	19.0	16.7	12.7	19.5	29.0	18.2	16.0
13	94	27.4	91	85	11.9	17.2	25.4	18.5	15.0	13.1	18.9	27.9	20.3	16.5
14	98	28.8	90	86	11.8	17.8	26.4	16.5	16.3	13.1	19.6	29.3	18.3	18.1
15	77	20.4	87.5	80	10.5	16.3	25.5	19.5	15.0	12.0	18.6	29.1	22.2	17.1
16	89	25.5	84	87.5	11.2	17.3	25.6	15.1	16.3	12.8	19.7	29.2	17.2	18.6
17	71	18.8	52.5	53.5	8.2	10.1	14.8	10.3	9.4	15.3	18.9	27.7	19.3	17.6
18	68	17.5	47.8	47.8	8.0	9.6	13.2	8.8	7.2	16.7	20.1	27.6	18.4	15.0
19	57	14.1	42.7	42.7	6.5	8.0	11.8	7.7	7.6	15.2	18.7	27.6	18.0	17.8
20	39.5	9.3	25.5	25.5	4.1	4.8	6.9	4.1	4.3	16.1	18.8	27.0	16.1	16.9
21	26.5	5.4	14.3	14.3	2.6	2.9	4.1	2.3	2.1	18.2	20.3	28.7	16.1	14.7
22	19.5	3.7	10.6	10.6	1.9	2.3	3.1	1.8	1.8	17.9	21.7	29.2	17.0	17.0
23	58.5	13.1	36.0	..	6.3	7.3	10.0	5.2	7.0	17.5	20.3	27.8	14.5	19.5
24	53	11.9	32.5	33.2	5.3	6.6	8.5	4.0	6.8	15.9	19.9	25.6	12.0	20.5
25	39	8.7	23.2	23.2	4.2	4.8	6.7	3.3	4.3	18.1	20.7	28.8	14.2	18.5
Average of specimens nos. 1—9										10.6	20.0	30.1	21.6	17.7
,, ,, ,, nos. 11—16										12.5	19.3	28.7	20.0	17.4
,, ,, ,, nos. 17—22										16.6	19.7	28.0	17.5	16.5

In specimens nos. 17—22 the chelipedes are equal, or nearly so, and there are no tubercles on the fingers. In nos. 17 and 18 an inconspicuous pubescence, sparse and

very short, is to be seen on the carpus and palm, in the other specimens it is invisible.

As regards the proportions of the segments in specimens of different sizes, it will be seen from the averages of the percentage figures that the most noticeable change is that the ischium becomes proportionately shorter with increased size, *i.e.*, it grows much more slowly than the other segments. Henderson and Matthai have found that this takes place in several Palaemons and it probably occurs in the males of most species of the genus. In the case of *P. rudis* the disproportionate growth of this segment is counterbalanced by a considerable increase in the length of the palm and by a less considerable increase in the carpus and dactylus. The merus in its relative length remains practically constant during growth.

Judging from the collection made in the Chilka Lake, the greater part of the change in the proportionate lengths of the segments takes place suddenly. In males in which the chelipedes are decidedly shorter than the total length (specimens up to about 70 mm.) the proportions are similar to those of females. In larger individuals, in which the larger chelipede is equal to, or less than one and a half times the total length, notable differences are found; but the ischium is still proportionately larger (12.5%) than in the largest examples—those in which the larger chelipede exceeds one and a half times the total length. From these facts it seems legitimate to infer that the change from the female type of limb to that characteristic of the fully grown male is, or may be, attained in two months.

A striking feature of the series of males from which the measurements given on p. 269 are derived, is that the appendix masculina is fully developed in all specimens except no. 22, in which it is rudimentary. As far as I am aware no precise observations have been made on the age at which this stylet becomes evident; but, from its intimate association with the sexual process, one would infer that it made its appearance only when the testes became functionally active. That it should be perfectly developed in specimens less than one quarter the maximum length of the species is most remarkable. Henderson and Matthai have already shown that a precocious sexual development may occur in at least some Palaemonidae, and it is probable that *P. rudis* affords an instance of the same phenomenon.

Three small males, nos. 23-25 of the series on p. 269, differ noticeably from any others in the collection in the great relative length of the dactylus. They differ in no other way from typical *P. rudis* of similar size, and I am inclined to regard them as abnormalites; it will be noticed that in normal specimens the dactylus is the most variable of all the segments of the chelipedes in its proportional length. It is possible that the great length of the fingers in these examples may indicate something more than an abnormality and that individuals with this character may be aggregated in certain localities to form a definite race; but at present we have no evidence that this is so.

The measurements of a series of females are shown on p. 271; of these all except the smallest (no. 11) bear eggs. The segments in their proportional lengths bear a close resemblance to those of young males and show but little change during growth;

a slight decrease in the relative length of the ischium is counterbalanced by an increase in the lengths of the palm and dactylus.

Number.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede.	Larger chelipede : length of					Proportionate lengths of segments of larger chelipede to total length of chelipede (100):				
					Ischium.	Merus.	Carpus.	Palm.	Dactylus.	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
1	103	27.8	84	84	12.2	15.8	23.1	16.0	13.6	14.5	18.8	27.5	19.0	16.2
2	94	25.0	65.5	65.5	10.4	12.7	18.6	11.8	10.2	15.9	19.4	28.5	18.1	15.6
3	92	23.9	63	64	10.1	12.7	17.5	12.4	10.6	15.8	19.8	27.3	19.3	16.5
4	92	23.6	61	25	9.9	12.2	17.7	10.0	9.3	16.2	20.0	29.0	16.4	15.3
5	84	21.1	58	58	8.9	11.1	15.2	10.9	9.4	15.3	19.1	26.3	18.7	16.2
6	83	21.0	55.5	55.5	9.1	11.1	16.0	10.6	9.3	16.4	20.0	28.8	19.1	16.7
7	86	21.4	55.5	55.5	9.0	11.2	16.3	9.7	8.7	16.2	20.2	29.3	17.5	15.7
8	82	21.0	49	49	8.4	10.0	14.0	8.5	7.2	17.1	20.4	28.6	17.3	14.7
9	67	16.8	43	43	7.0	8.7	12.4	7.1	6.3	16.3	20.2	28.8	16.5	14.6
10	51	12.9	33	27	5.9	6.9	9.5	5.6	4.7	17.9	20.9	28.8	17.0	14.2
11	35.5	7.2	18.3	18.3	3.3	3.9	5.1	2.8	2.7	17.9	21.3	27.8	15.3	14.7
Average ..										17.2	20.0	28.2	17.7	15.5

In life, females and young males differ noticeably in colour from adults of the latter sex. In young specimens and in females there is a pair of dark dorso-lateral streaks on the carapace and distinctive dark lateral markings. The first of these is situated on the gill-cover and is U-shaped with the anterior limb of the U turned forwards towards the base of the antennal scale. Behind this is another mark which is Γ-shaped and placed, not on the branchiostegite, but on the inner wall behind the gills. On the abdomen there is a faintly marked transverse patch at the end of the third abdominal somite and the margins of the pleura are dusky. The antennules are dull red and there is a conspicuous streak of reddish chromatophores up the middle of the antennal scale. All the legs are suffused with reddish-purple, the joints being tinged with orange yellow. The chelae of the second legs are not marbled as in the young individuals referred to *P. malcolmsoni*, and the fingers are reddish or colourless. The telson and uropods are stained with reddish-brown. In very large females the margins of the abdominal pleura are whitish and the claws of the second legs obscurely marbled with yellow. The distinctive colour markings on the carapace are faint or absent and there is, in general, a very marked resemblance to adult females of *P. malcolmsoni*.

Large males are of an almost uniform dull bluish or greenish-grey colour which becomes darker and has a mottled appearance on the telson and uropods. The antennules and antennae are grey and the scale is transparent in its external half, but possesses internally a broad dark grey longitudinal band. The second legs are dark bluish-grey, paler beneath and conspicuously mottled above with a very pale

grey. A broad and well defined pale streak extends along the dorsal surface of the merus, ischium and palm and is especially distinct on the last segment. The other legs are pale, slightly darker on the dactylus and at the distal end of the propodus.

Adults of both sexes of this species were found not uncommonly in the Chilka Lake in the months of September and November, when the water was fresh or very slightly brackish. During the former month they were obtained in abundance at Barkul, where they are trapped in large numbers by the fishermen. Specimens were also found off Nalbano, near Barnikuda I., and in the vicinity of Arupatna in the outer channel. In the last locality they were found on the banks among submerged roots of screw-pines. The females found at this season of the year were bearing eggs.

No adults of either sex were found at any other time of the year; but young individuals were frequently met with in February and March round the rocks at the foot of Ganta Sila, at Chiriya I. and at Barkul Point, in water of moderate salinity (sp. gr. 1.009—1.011), and in the latter month were abundant at Satpara in water as salt as that of the Bay of Bengal near the lake (sp. gr. 1.0265).

We are convinced that in this species—and the facts already brought forward in reference to *P. malcolmsoni* tend to show that the same is the case with it also—the prawns, when they have attained a certain size, leave the lake and, during the monsoon, resort to the flooded rice-fields and other bodies of fresh water to which ingress is easy. In the freshwater season, probably that of the following year, they return to the lake when the eggs of the females are ripe. At this period, in the case of *Palaemon rudis*, adult males accompany the females, whereas in *P. malcolmsoni* it is apparently only the latter sex that visits the lake at the breeding season. In the last species impregnation of the ova probably takes place outside the lake before the annual migration of the females has begun.

Palaemon rudis is known from E. Africa, Mozambique, Madagascar and Ceylon. The species is not uncommon in the vicinity of Calcutta and is recorded by Henderson and Matthai from Coconada and Madras.

Palaemon scabriculus, Heller.

1910. *Palaemon scabriculus*, Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 296, pl. xvii, figs. 7a-c, pl. xviii, figs. 7a-p.

To this species I refer two specimens caught by fishermen near Rambha at the south end of the lake. One of them, in which there is a marked inequality in the second pair of legs, is, I believe, a young male; the appendix masculina, however, is not developed and the large chelipedes only bear scanty hairs in place of the dense felted coating found in adults. The other individual is a female.

In the female the rostrum bears twelve teeth above and two beneath and reaches a little beyond the end of the antennular peduncle. In the male there are thirteen dorsal teeth and two ventral, the blade reaching only to the end of the peduncle. The four proximal dorsal teeth, in both cases, are situated on the carapace behind the orbit.

The specimens yield the following measurements (in mm.):—

Sex.	Total length.	Length of carapace.	Length of right chelipede.	Length of left chelipede.	Larger chelipede : length of				
					Ischium.	Merus.	Carpus.	Palm.	Dactylus.
♀	54	14.4	33	31.5	5.2	6.7	7.0	6.8	5.8
♂	47.8	12.0	26.3	30.6	4.7	6.3	6.1	6.8	5.4

P. scabriculus must be regarded merely as an occasional visitor to the lake. It is evidently very scarce and there is little likelihood that it ever breeds in the water near Rambha which, throughout the year, retains some trace of salinity. At the time the specimens were obtained the specific gravity of the water in this neighbourhood was 1.011.

Other references to *P. scabriculus* will be found in the paper cited above. The species is common in S. India and is known from Kotri on the R. Indus and from Pondicherry. It has also been recorded from Ceylon, from Saleyer and from Celebes.

Genus LEANDER, Desmarest.

Leander styliferus (Milne Edwards).

1837. *Palaemon longirostris*, Milne-Edwards, *Hist. nat. Crust.*, II, p. 394 (not *P. longirostris*, *ibid.*, p. 392).
 1840. *Palaemon styliferus*, Milne-Edwards, *Hist. nat. Crust.*, III, p. 638 (*nom. nov.* for *P. longirostris*, *loc. cit. supra*, p. 394).
 1893. *Leander longirostris*, Henderson, *Trans. Linn. Soc., Zool.* (2), V, p. 439.
 1902. *Palaemon styliferus*, Rathbun, *Proc. U.S. Nat. Mus.*, XXVI, p. 51.
 1908. *Leander* sp., de Man, *Rec. Ind. Mus.*, II, p. 220, pl. xviii, fig. 3.

The single specimen of this species found in the Chilka Lake is a non-ovigerous female 62 mm. in total length: it agrees closely with Henderson's description. The basal crest of the rostrum bears six teeth and there are two other dorsal teeth near the apex; on the lower margin are eight teeth. The mandibular palp, as in the genus *Palaemon*, is composed of three segments.

The specimens recorded by de Man from Amoy in China¹ appear to be distinct from this species. Apart from the differences noted by de Man in the proportions of the branchiostegal and antennal spines (explained by Henderson as a clerical error in the description), the short filament of the antennules is much longer in the Chinese specimens and the second peraeopods considerably shorter. These legs in large individuals from the Gangetic Delta reach beyond the antennal scale by the whole length of the carpus and chela and, in smaller specimens, by at least the entire length of the chela. The fingers in Indian examples are always much longer than the palm.

¹ De Man, *Notes Leyden Mus.*, III, p. 141 (1881).

The forms described by Ortmann¹ under the names *Leander longirostris* var. *japonicus* and var. *carinatus* are now regarded as distinct species.² The specimens recorded by de Man (*loc. cit.*) under the name *Leander* sp. are almost certainly young examples of *L. styliferus*.

Leander styliferus is extremely common in brackish water in the Sunderbuns and the Gangetic delta, the locality from which the original specimens described by Milne-Edwards were obtained. It is also recorded by Henderson and Miss Rathbun from Karachi and by the former author from Mergui and the Gulf of Martaban.

The species is evidently nothing more than a casual visitor to the Chilka Lake. The single specimen obtained was found at Satpara in March 1914, in water of the same salinity as that of the Bay of Bengal in the vicinity.

Genus UROCARIS, Stimpson.

1860. *Urocaris*, Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, XII, p. 39.

1902. *Urocaris*, Rathbun, *Bull. U.S. Fish Comm. for 1900*, XX, ii, p. 126.

Urocaris is one of the genera which lie on the border-line between the Pontoniidae and Palaemonidae, families which until recently have been regarded as distinct. The absence of a palp on the mandible and the rather deeply cleft outer antennular flagellum induced most authors to regard it as an ally of *Palaemonetes*, but Sollaud³ has very correctly pointed out that the reduced gill-formula and the presence of three pairs of spines at the apex of the telson indicate a position near *Periclimenes* and other less specialized genera of the old Pontoniidae.

In the species of *Urocaris*, found in the Chilka Lake, the branchial formula is as follows:—

		VII	VIII	IX	X	XI	XII	XIII	XIV
Exopods	..	I	I	I	..	..	..	..	..
Podobranchs	..	ep.	ep.	ep.	..	..	..	..	..
Arthrobranchs	..	..	..	I	..	..	..	..	..
Pleurobranchs	..	..	..	..	I	I	I	I	I

This formula is almost identical with that found in *Periclimenes*, from which, however, *Urocaris* may be separated by the more deeply cleft outer antennular flagellum and by the great length of the last abdominal somite. In *Urocaris*, also, the inferior portion of the rostrum, *i.e.* that situated below the midrib, is ill-developed or absent and ventral teeth, if present, are placed close to the apex. These characters are not very convincing, though, in combination, they give the typical species of the genus a very distinct facies.

¹ Ortmann, *Zool. Jahrb., Syst.*, V, pp. 519-521, pl. xxxvii, figs. 14, 14z.

² See Rathbun, *loc. cit.*, and Doflein, *Abhandl. k. bayer. Akad. Wiss.*, XXI, p. 639, pl. iii, fig. 8 (1902).

³ Sollaud, *C. R. Acad. Sci., Paris*, Dec., 1910, p. 1.

In *U. longicaudata*, Stimpson, the type species of the genus, and in its two near allies, *U. infraspinis*, Rathbun, and *U. indica*, described below, the dactyli of the last three peraeopods bear a slender inferior spine, thus differing notably from all *Periclimenes*. In the two other described species of *Urocaris*, *U. longipes*, Stimpson, and *U. psamathe*, de Man, forms which differ widely from the more typical representatives of the genus, the dactyli are stated to be unarmed. In *U. psamathe* the mandible has apparently not been examined and in both species we lack information regarding the branchial formula.

***Urocaris indica*, sp. nov.**

(Plate XIII, fig. 9.)

? 1905. *Urocaris longicaudata*, Pearson (*nec* Stimpson), *Rep. Pearl Oyster Fisheries, Ceylon*, IV, p. 78, pl. i, figs. 5, 5a.

The rostrum reaches almost to the end of the antennular peduncle. The upper portion of the blade, that is to say that situated above the midrib, is deep and forms a strongly arched crest rising above the general level of the carapace and armed with 8, 9 or 10 more or less evenly spaced teeth.¹ The first of these teeth is situated a little behind the orbit, while the second is immediately above it. The crest is continued backwards as a well-marked carina for two-thirds the length of the carapace and bears, a little in front of the middle point of the latter, a single isolated spine. The portion of the rostral blade below the midrib is obsolete and the lower edge is, in consequence, straight or even a trifle concave. This margin is unarmed throughout the greater part of its length; but, close to the apex and below, or in front of the most distal tooth of the dorsal series, bears from 1 to 3 (usually 2) minute teeth (pl. xiii, fig. 9).

The carapace, except for the median carina noticed above, is smooth. It is provided with sharp antennal and hepatic spines and the sub-orbital angle is narrowly produced and rounded at the extremity.

The eyes are rather long, reaching almost to the end of the basal antennular segment; they possess a well-defined ocellus.

The lateral process of the antennular peduncle (text-fig. 26a) has the form of a sharp external spine situated at the proximal end. The outer margin in front of this process is convex; it bears a strong spine anteriorly and is continued forwards beyond this to a point much in advance of the insertion of the second segment. The extreme length of the basal segment is about twice that of the two following combined. The outer antennular flagellum is distally divided into two unequal rami, the inner long and slender, the outer stout and, including the basal fused portion, of a length equal to that of the peduncle. The length of the stout outer branch is variable, but usually less than half that of the fused portion.

The antennal scale (text-fig. 26b) reaches only a trifle beyond the antennular peduncle. It is from three and a third to three and three quarter times as long as

¹ In one wholly abnormal specimen there are only five dorsal teeth.

wide and the broad but rather sharply angled apex of the lamella extends beyond the spine which terminates the straight outer margin for a distance not greater than the length of the spine.

The mandible is without palp; the incisor process terminates in three teeth. The epipod of the first maxillipede is a little emarginate but is not bilobed. The exopod of the third maxillipede reaches about to the end of the antepenultimate segment, which is furnished with a variable number of spinules on its outer margin. The ultimate segment is about two-thirds the length of the antepenultimate.

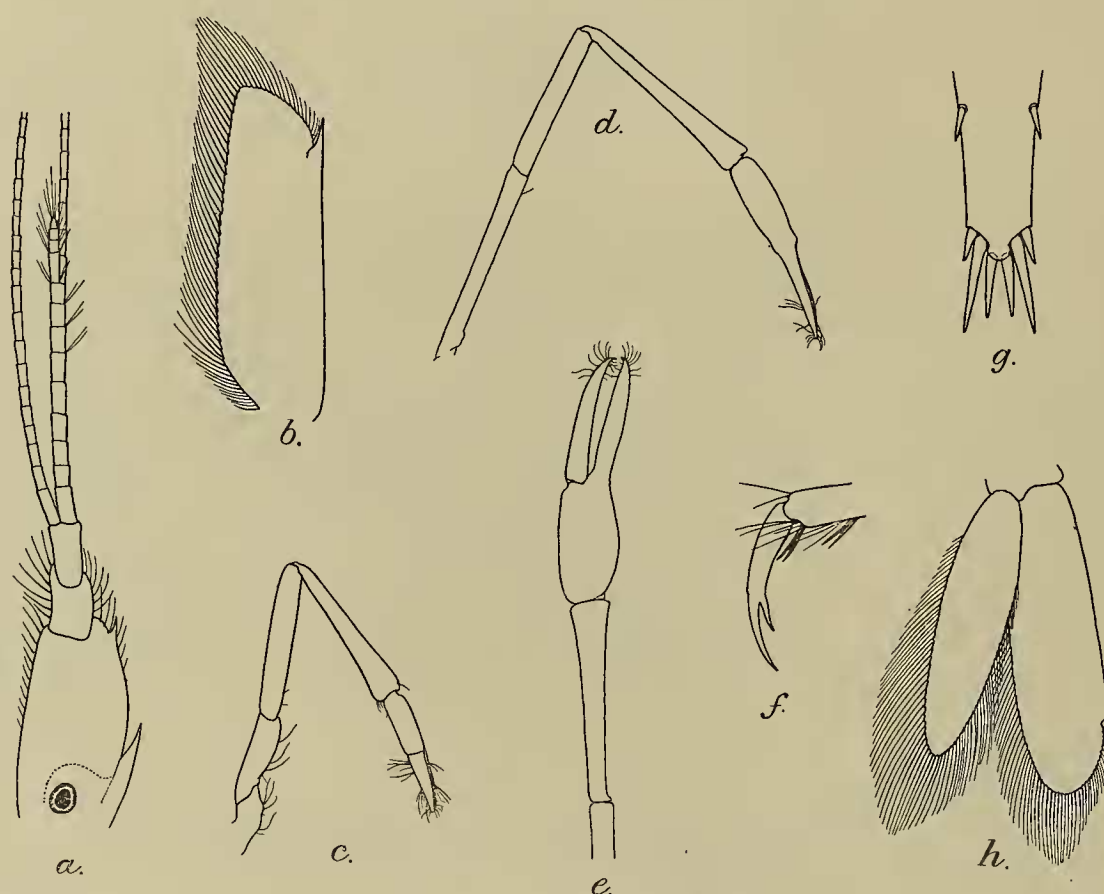


FIG. 26.—*Urocaris indica* sp. nov.

- | | |
|----------------------|--|
| a. Antennule. | e. Carpus and chela of 2nd peraeopod from above. |
| b. Antennal scale. | f. Dactylus of fifth peraeopod. |
| c. First peraeopod. | g. Apex of telson. |
| d. Second peraeopod. | h. Uropods. |

The first peraeopods (text-fig. 26c) reach to two-thirds the length or almost to the apex of the antennal scale. The merus and carpus are of equal length and about one sixth longer than the chela. The dactylus is equal in length to the palm and there are a few tufts of setae on the fingers, at the base of the palm and at the distal end of the carpus.

The second peraeopods (text-figs. 26d, e) reach beyond the end of the scale by the length of the fingers and sometimes by almost the entire length of the palm as well. The lengths of the segments (in mm.) of seven specimens are as follows:—

Sex.	Second peraeopod : length of				
	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
♀	1·8	1·4	1·75	·9	1·0
♀	1·5	1·2	1·4	·7	·7
♀	1·5	1·0	1·4	·7	·8
♀	1·4	1·1	1·4	·8	·9
♀	1·3	1·1	1·4	·7	·8
♂	1·2	·9	1·2	·6	·65
♂	1·0	·7	1·0	·4	·4

The fingers are provided with inturned claws and with a few setae placed distally, but are without teeth on the cutting margins. There are no spines on any of the segments.

The third peraeopods reach almost or quite to the end of the antennular peduncle; those of the fifth pair are a little longer. In all the last three pairs the posterior margins of the propodi bear tufts of longish setae and the dactylus is naked and biunguiculate, bearing a slender spine near the apex (text-fig. 26f). In those of the fifth pair the ischium and carpus are of equal length; the carpus is a little more than half the length of the merus and a little less than half the length of the propodus; the latter segment is rather less than four times as long as the dactylus.

The abdominal somites are smooth; the third is somewhat strongly arched in lateral view and overhangs the succeeding somite. The sixth somite is about twice the length of the fifth and is a little longer than the telson.

Both uropods extend beyond the apex of the telson, the outer being the longer and about three and a half times as long as broad (text-fig. 26h). The telson is narrow with two pairs of dorso-lateral spinules. The apex (text-fig. 26g) is produced in the middle to a bluntly rounded lobe and bears three pairs of spinules. The tips of the inmost pair fall only a little short of those of the intermediate pair, the outermost being much the shortest.

Large ovigerous females reach a length of nearly 16 mm.

Urocaris indica is very closely allied to *U. infraspinis*, Rathbun¹, from California and the Pacific coast of Mexico. It agrees with this species and differs from *U. longicaudata*, Stimpson², the type of the genus, in possessing an antennal spine and a well defined ocellus at the base of the cornea. The characters separating *Urocaris infraspinis* from the form found on the Indian coasts appear to be as follows :—

¹ Rathbun, *Proc. U. S. Nat. Mus.*, XXIV, p. 903 (1902) and *Harriman Alaska Exped.*, X, p. 31, text-figs. 10a, b (1910).

² This species, examples of which I have examined, is recorded from the West Indies and the adjacent eastern coast of America. See Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, XII, p. 39 (1860) and Rathbun, *Bull. U.S. Fish Comm. for 1900*, XX, ii, p. 126 (1902).

U. infraspinis.

Rostrum slightly shorter, with 5-7 teeth above¹ and 1 or 2 below.

Basal segment of antennular peduncle narrower, its outer margin nearly straight.

Apex of antennal scale produced far beyond the spine which terminates the outer edge.

Second peraeopods with merus and ischium subequal; palm a little shorter than ischium.

Sixth abdominal somite less than twice as long as fifth.

Size larger, up to about 21 mm.

U. indica.

Rostrum slightly longer, with 8-10 teeth above¹ and 2 or 3 below.

Basal segment of antennular peduncle broader, its outer margin convex.

Apex of antennal scale produced not so far beyond the spine which terminates the outer edge.

Second peraeopods with merus decidedly shorter than ischium; palm little, if at all, more than half the length of ischium.

Sixth abdominal somite twice as long as fifth.

Size smaller, not more than 16 mm.

Some of these distinctions would perhaps break down on actual comparison of specimens, while others, possibly of greater value, might be found.

With the two remaining described species of *Urocaris*, *U. longipes*, Stimpson² and *U. psamathe*, de Man³, the Indian form has little in common.

I think it very probable that the specimen recorded by Pearson (*loc. cit.*) under the name *U. longicaudata*, Stimpson, from the Ceylon Pearl Banks should be referred to this species. In the Indian Museum are numerous examples of *U. indica* obtained at the north end of the Gulf of Manaar, a locality not far distant from the Pearl Banks, and these are indistinguishable from individuals found in the Chilka Lake. The fact that an antennal spine was present in Pearson's example clearly indicates that it was incorrectly referred to the West Indian species; in the figures, however, no ocellus is shown and the rostrum is less elevated than in any example of *U. indica* that I have seen.

Examined when alive, specimens of *Urocaris indica* are almost perfectly transparent to the naked eye, but under a lens small speckles of white arranged in transverse rows are seen on the abdomen, at the tip of the telson, on the uropods and on the eyestalks. There are also minute maroon specks on the carapace and abdomen, the amount of pigmentation present varying greatly in different individuals. The eggs borne by the females are sage green in colour.

This species is very common in the Chilka Lake, especially near the shores among weeds. It is extremely abundant at the south end of the lake and at Barkul and is equally common at localities near the inner end of the outer channel, where the bottom is composed of muddy sand and weed is plentiful. The species is able to tolerate extreme variations in salinity, having been found in water that was quite fresh as well as in that which was as salt as the Bay of Bengal near the lake.

Ovigerous females were found in February, March, July and September. In the latter month, however, egg-bearing individuals were obtained only at the south

¹ Excluding the tooth situated on the carapace behind the rostrum.

² Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, XII, p. 39 (1860).

³ De Man, *Abhandl. Senckenb. naturf. Ges., Frankfurt*, XXV, p. 816, pl. xxv, fig. 51 (1902).

end of the lake in water which was slightly brackish; no ovigerous specimens were seen out of many collected during this month at other localities in fresh water, and it appears that the species breeds only in water containing some trace of salinity.

In addition to a long series from the Chilka Lake, there are in the Indian Museum specimens of *U. indica* found by Dr. Annandale at Ennur and in the Adyar R. near Madras, and others which I myself obtained living in pure sea-water inside the fringing coral-reef at Kilakarai at the northern end of the Gulf of Manaar. The specific gravity of the water in which specimens were taken at Ennur in January 1915, varied from 1.000 to 1.0045; the collection includes numerous ovigerous females, but there had been a sudden inflow of fresh water, abnormal at that time of year, just previous to their capture.

The type specimens bear the number 8997-8/10 in the Indian Museum register.

Genus PERICLIMENES, Costa.

1852. *Anchistia*, Dana, *U. S. Explor. Exped.*, *Crust.*, I, p. 577.

1898. *Periclimenes*, Borradaile, *Ann. Mag. Nat. Hist.* (7), II, p. 380

Periclimenes demani, sp. nov.

(Plate XIII, fig. 10.)

The carapace is smooth with broadly rounded antero-lateral angles. Supra-orbital and hepatic spines are present, the latter being placed a little below the level of the antennal spine.

The rostrum, in the female, reaches almost or quite to the apex of the antennal scale, sometimes a little beyond it in the male; in lateral view the blade is broad in front of its middle point and is very slightly upturned towards the apex. On the upper edge there are 7 to 9 teeth and on the lower 1 to 3; in nearly all the specimens there are 8 or 9 above and 2 or 3 below. The proximal tooth is remote from the rest of the series and is situated on the carapace at the junction of the middle and anterior thirds of its length. The second tooth is placed over the orbit and from this onwards the teeth are, as a rule, regularly spaced; the distal tooth is usually situated close to the apex (pl. xiii, fig. 10).

The cornea of the eye is a trifle wider than the stalk and in the female is, as in some allied species, traversed by a dark band. The band commences near the ocellus—which in this species is conspicuous—and extends round the inner half of the cornea, meeting the stalk again on its ventral side.

The antennular peduncle (text-fig. 27a) extends to about two-thirds the length of the antennal scale. The broad basal segment is more than one and a half times the length of the second and third segments combined; its outer margin is furnished proximally with a spine-like lateral process and terminates in a stout tooth; the margin inwards of this tooth is strongly sinuous and is bordered with setae. The outer flagellum is unequally bifid distally and the thickened part (*i.e.* the fused portion, composed of 12 to 14 segments, + the stouter and shorter of the two terminal

branches) extends beyond the apex of the antennal scale by two-thirds of its length in the male, by a little less in the female.

The antennal scale (text-fig. 27*b*) is about three and three quarter times as long as broad in large females, about four and a half times as long as broad in males. The outer margin is nearly straight in the female, a little concave in the male, and terminates in a spine which reaches to, or a trifle beyond, the apex of the lamella; the apical portion of the latter is not strongly narrowed as in *P. ensirostris* (Dana).

The mandible is without palp. The molar process is trilobed terminally and the incisor process ends in three sharp teeth.

The outer maxillipedes reach to the end of the antennal peduncle. The ante-

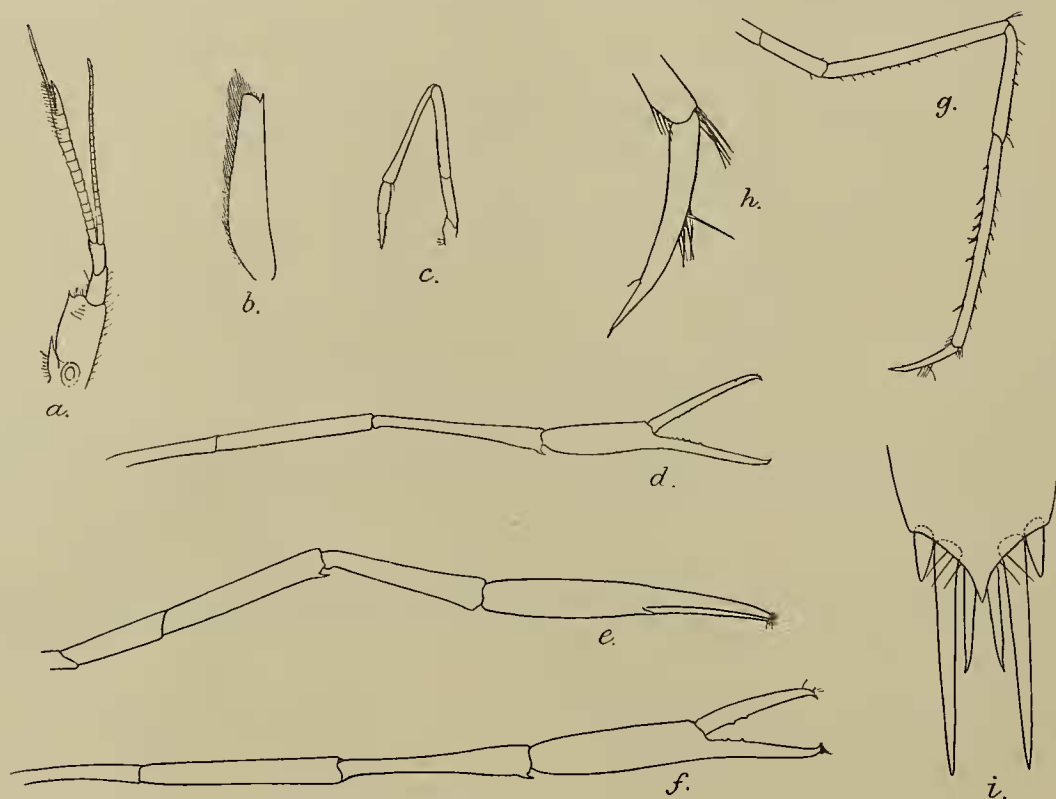


FIG. 27.—*Periclimenes demani*, sp. nov.

- | | |
|---|---|
| a. Antennule. | e. Second peraeopod of female from L. Chilka. |
| b. Antennal scale of male. | f. Second peraeopod of female from Madras. |
| c. First peraeopod. | g. Fifth peraeopod. |
| d. Second peraeopod of male from L. Chilka. | h. Dactylus of fifth peraeopod. |
| | i. Apex of telson. |

penultimate segment is exceeded in length by the exopod and its outer margin is as a rule bare, without spinules or setae. The ultimate segment is about three quarters the length of the penultimate.

The first peraeopods (text-fig. 27*c*) reach a trifle beyond the antennal scale. The carpus is about one-fifth longer than the merus and nearly twice the length of the chela. The palm is a little shorter than the fingers and bears on its inner face numerous setae arranged in transverse rows. The fingers also bear a few tufts of setae on their margins and are without teeth on the cutting edge.

The second peraeopods (text-figs. 27*d*, *e*, *f*) are equal. In the female they extend beyond the apex of the antennal scale by the length of the chela, or, in very large

individuals, by the length of the chela and half the carpus. In the male they are decidedly longer proportionately, reaching beyond the scale by the chela and two-thirds the length of the carpus. The limbs of five separate specimens yield the following measurements¹ (in mm.) :—

Sex.	Second peraeopod : length of				
	Ischium.	Merus.	Carpus.	Palm.	Dactylus.
♂	2.2	3.2	3.2	2.0	2.1
♂	2.0	2.9	3.0	1.9	2.1
♀	2.1	3.2	3.3	2.4	1.8
♀	2.0	2.7	2.7	2.2	1.5
♀	2.0	2.6	2.7	2.1	1.6

It will be seen that the merus and carpus are about equal in length and that the latter segment is considerably longer in the male than in the female and in the former sex is conspicuously longer than the palm. The fingers in the male are a little longer than the palm, while in the female they may be less than three-quarters its length. There is a spine at the distal end of the merus, situated inferiorly, and one at the distal end of the carpus, placed internally. There are a few very small teeth, sometimes as many as six, on the inner half of the fixed finger and others, still more minute, similarly placed on the dactylus.

The third, fourth and fifth pairs of peraeopods reach to, or a little beyond, the apex of the antennal scale. In those of the fifth pair (text-fig. 27g) the propodus is a trifle longer than the merus, about twice the length of the carpus and nearly three times the length of the dactylus. The propodus bears setae at its distal end and five or six spinules on the inner border; the dactylus is slender, slightly curved and with a few setae in the middle of its outer margin.

The only gills which are well developed are the five pleurobranchs. The pleurobranch found in *Palaemon* at the base of the third maxillipedes is absent, while the arthrobranch of the same segment is represented only by a few lamellae. There is, apparently, no trace of a podobranch on the second maxillipede.

There is a marked difference between the sexes in the form of the pleopods. In the male the protopodite is about equal in length to the exopod, whereas in the female it is proportionately half as long again. The greater length of the segment in the latter sex is correlated with the greater depth of the abdominal pleura; it is doubtless a provision to enable the pleopods to have free play when the female is heavily laden with eggs.

The abdominal somites are smooth; the sixth is little more than half the length

¹ These measurements are taken from specimens found in the Chilka Lake. In ovigerous females from the neighbourhood of Madras, which are of considerably larger dimensions, and in a few examples from the Chilka lake (text-fig. 27e) the palm is a little longer proportionately, about equal in length with the carpus and merus. In a male from Madras the proportional lengths of the segments of the second leg are much as in the Chilka specimens, but the limb is longer, reaching beyond the apex of the scale by the chela and the whole length of the carpus.

of the telson (terminal spines included). The outer and inner uropods are equal in length, the former being about two and a fifth times as long as broad. The telson bears two pairs of dorso-lateral spinules and is not sulcate above; the apex (text-fig. 27*i*) is sharply acute and is furnished with three pairs of spines, those of the intermediate pair twice, or more than twice, the length of the inner and several times longer than the outer.

Eyed eggs borne by females are about 0.58 mm. by 0.44 mm. in longer and shorter diameters.

Large specimens from the Chilka Lake do not exceed 21 mm. in total length; individuals from the Madras backwaters are frequently larger, up to 25 mm. in length.

The presence of supra-orbital and hepatic spines and the long and slender carpus of the second peraeopods, outstanding characters of *P. demani*, are shared by six described representatives of the genus; namely—

Periclimenes aesopius (Bate).

1863. *Anchistia aesopia*, Bate, *Proc. Zool. Soc., London*, p. 502, pl. xli, fig. 5.

Periclimenes danae (Stimpson), Borradaile.

1898. *Periclimenes danae*, Borradaile, *Proc. Zool. Soc., London*, p. 1004, pl. lxiii, figs. 4, 4*a*, *b*.

Periclimenes edwardsi (Paulson).

1875. *Anchistia edwardsii*, Paulson, *Crust. of the Red Sea*, p. 114, pl. xvii, figs. 2, 2*a*, *b*.

1906. *Anchistia edwardsi*, Nobili, *Ann. Sci. nat., Paris*, (9), iv, p. 53.

Periclimenes elegans (Paulson).

1875. *Anchistia elegans*, Paulson, *ibid.*, p. 113, pl. xvii, figs. 1, 1*a-h*.

1906. *Anchistia elegans*, Nobili, *ibid.*, p. 52.

Periclimenes ensifrons (Dana) [= *P. vitiensis*, Borradaile and ? *P. grandis* (Stimpson)].

1852. *Anchistia ensifrons*, Dana, *U.S. Explor. Exped., Crust.*, I, p. 578, pl. xxxvii, figs. 5*a-l*.

1902. *Periclimenes ensifrons*, de Man, *Abhandl. naturf. Ges. Frankfurt*, XXV, p. 826.

Periclimenes tenuipes (Holmes nec Borradaile).¹

1900. *Anchistia tenuipes*, Holmes, *Occas. Papers California Acad. Sci.*, VII, p. 216.

1910. *Periclimenes tenuipes*, Rathbun, *Harriman Alaska Exped.*, X, *Crust.*, p. 34, text-fig. 12.

P. aesopius is readily distinguished from *P. demani* by the form of the third abdominal somite which is "postero-dorsally carinated and elevated into a hump-like tooth." From all the other species listed above *P. demani* may be distinguished

¹ I am unable to understand Nobili's statement (*Ann. Mus. Zool. Napoli*, II, 1907, No. 21, p. 5) that Heller regarded *Palaemon biunguiculatus* as a synonym of "*Periclimenes tenuipes*, Leach." Heller in 1857 (*Crust. südlich. Europ.*, p. 256) cites *P. unguiculatus* as a synonym of *Anchistia scripta*; but there is no reference to any species of Leach and I am unable to discover that that author ever described a Palaemonid under the name of *Periclimenes tenuipes*. If this is so, *tenuipes* may legitimately be used for the Californian species described by Holmes, while *P. borradailei*, Rathbun (1904) should be employed for *P. tenuipes*, Borradaile. Nobili (*Bull. sci. France Belg.*, XL, 1906, p. 42) has suggested the name *brevinaris* for the form which he described in the preceding year (*Bull. Mus. d'Hist. Nat., Paris*, 1905, p. 159) as *P. borradailei*.

by the greater length of the carpus of the second peraeopods which, even in the female, is as long or longer than the palm.

In addition it differs notably from *P. ensifrons* and *P. elegans* in the form of the antennal scale, which in those species is concave externally and terminates in a spine which far outreaches the narrow apex of the lamella. *P. danae*, as identified and figured by Borradaile, has three posterior rostral teeth situated on the carapace and the ultimate segment of the outer maxillipedes (according to the figure) only about half the length of the penultimate. In *P. edwardsi* two posterior rostral teeth are placed on the carapace and the antennular peduncle is longer, reaching the apex of the antennal scale.

In the scheme of classification recently proposed by Borradaile¹ *P. demani* apparently finds a place in the subgenus *Falciger*.

Periclimenes demani, when alive, is transparent, speckled with greenish-yellow chromatophores. A dark brown stripe is conspicuous in lateral view on either side of the mouth and another similar stripe in front of the first pair of legs. The rostrum, antennules and antennae are transparent with occasional greenish-yellow chromatophores. The legs are entirely transparent, except for the fingers of the large claw which are bluish, and for a suffusion of bright orange yellow at the junction of the fingers and palm of the same limb. On the thoracic sternum is a broad transverse maroon band which involves the basal segments of the third legs. The margins of the abdominal pleura and uropods are mottled with maroon and the eggs are sage green.

The species is not uncommon in the Chilka Lake, though much less abundant than *Urocaris indica*. Unlike the latter form it is entirely absent from the main area of the lake. It has been found in numerous localities in the outer channel, living among weeds in quite shallow water; it has been taken off Barnikuda I., in Seruanaddi, at Satpara, near Mahosa, and, in the flood season, among submerged vegetation near Manikpatna.

The species appeared to be equally abundant both in March, where the water was of the same salinity as that of the sea outside the lake and in September when it was quite fresh. In March the breeding season was just beginning, a few females bearing eggs that were not eyed; by September it was apparently almost over, or a second breeding period was almost completed, for the eggs borne by the single ovigerous female that was then obtained were fully eyed and on the point of hatching.

The specimens from the neighbourhood of Madras, where the species appears to be commoner than in the Chilka Lake, are, as already noted, of a larger size than those found in the Chilka Lake. They were obtained by Dr. Annandale in October 1913, in the Adyar River in water that was almost fresh, and also in the Ennur backwater in January 1915, in water of specific gravity varying from 1.000 to 1.0045. On both occasions ovigerous females were taken.

The type specimens bear the number 8981-4/10 in the Indian Museum register.

¹ Borradaile, *Ann. Mag. Nat. Hist.* (8), XV, p. 207 (1915).

Family ALPHEIDAE.

Five species of Alpheidae occur in the Chilka Lake, but only two of them, *Alpheus crassimanus* and *A. paludicola*, inhabit the main area. All of them are able to exist in pure fresh water as well as in water as salt as that of the Bay of Bengal in the vicinity of the lake. The species of *Athanas* is remarkable for the existence in the males of a well-marked trimorphism.

Genus OGYRIDES, Stebbing.

1860. *Ogyris*, Stimpson, *Proc. Acad. Nat. Sci. Philadelphia*, XII, p. 36.

1899. *Ogyris*, Coutière, *Ann. Sci. nat., Zool.* (8), IX, p. 332.

1911. *Ogyris*, de Man, *Decap. 'Siboga' Exped.*, II, Alpheidae, p. 135.

1914. *Ogyrides*, Stebbing, *Ann. S. African Mus.*, XV, p. 31.

The name *Ogyrides* has recently been proposed by Stebbing in substitution for Stimpson's *Ogyris*, preoccupied by Doubleday (1847) in Lepidoptera.

The genus is extremely abnormal in type, exhibiting in the feeble dimensions of the first peraeopods a condition which is in all probability primitive, while the attenuated eyestalks, the form of the antennular peduncle and antennae, the great length of the exopods of the first two pairs of maxillipedes and the reduced branchial formula are indications of extreme specialization. The relationship of *Ogyrides* with more typical Alpheidae is traced through *Automate*, a genus in which the antennular peduncle and antennal carpocerite are of great length and in which, as in *Ogyrides*, the eyes are not concealed.

The branchial formula of the species of *Ogyrides* found in the Chilka Lake is as follows:—

	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs ..	ep.	ep.	ep.	..	..	..	..	..
Arthrobranchs ..	..	..	..	..	..	..	..	..
Pleurobranchs ..	..	..	..	I	I	I	I	I

The branchiae are fewer in number than in any other genus of Alpheidae; but, except for the absence of an arthrobranch at the base of the third maxillipede, the formula resembles that found in *Cheirothrix* and *Synalpheus*.¹

The single species of this genus found in the Chilka Lake appears to find its nearest ally in a form recorded from the mouth of the Tocantins River in Brazil.

Ogyrides striaticauda, sp. nov.

The rostrum is flat and triangular and slightly curved downward distally; it scarcely reaches beyond the infero-orbital angle of the carapace (text-figs. 28a, b). The apex is acute and the margins are furnished with setae. Behind it the carapace is keeled in the mid-dorsal line for nearly half its length, the carina bearing a series of

¹ Cf. Coutière, *Ann. Sci. nat., Zool.* (8), IX, p. 276 et seq. (1899).

from 7 to 9 forwardly directed teeth. On either side the carapace is rather thickly clothed with plumose setae. A cervical groove (*e* of Boas' terminology) is distinct, the orbits are semicircular, the infero-orbital angle bluntly rounded and the pterygostomian obtusely pointed.

The eyes are very long and slender and extend beyond the antennular peduncle for a distance equal at least to the length of the last segment of the latter. The stalks are broad at the base, but very narrow in the middle, expanding slightly at the distal end. Each bears a row of setae on the inner margin towards the end of the proximal third of its length.

The basal segment of the antennular peduncle reaches to half the length of the

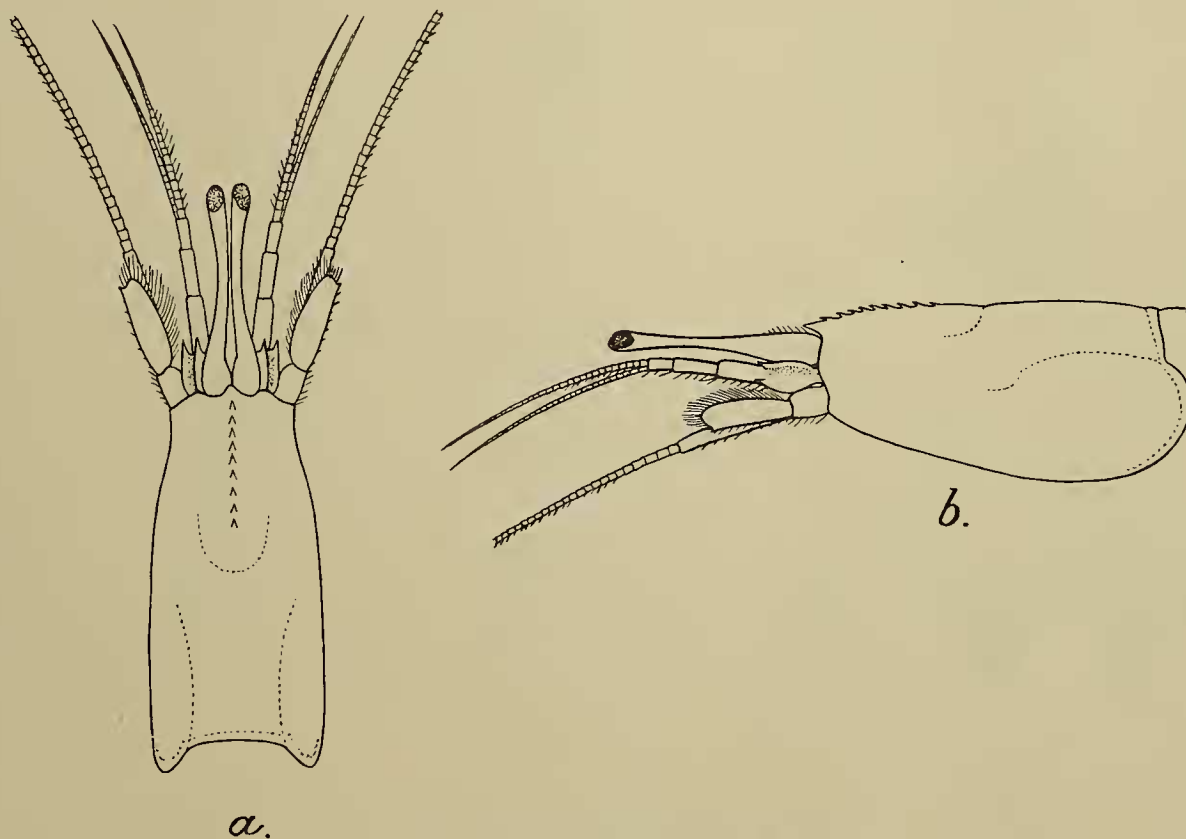


FIG. 28.—*Ogyrides striaticauda*, sp. nov.
Carapace and anterior appendages. *a*. Dorsal view. *b*. Lateral view.
The fine setae on the carapace are not shown.

eyestalks. The lateral process has two ridges, the lower, which corresponds to the outer margin of the process in normal forms and the upper, which is nearly vertical and lies close to the outer edge of the eyestalk. Each of these ridges terminates anteriorly in a strong spine; the tips of the spines are on a level and reach to about three fifths the length of the segment. The second segment of the peduncle is rather more than half the length of the first and the third about half the length of the second. The flagella are of the same length, about as long as the peduncle.

The basicerite of the antenna bears a single external spine; the carpocerite is very long, reaching to the last segment of the antennular peduncle. The antennal scale reaches only to the middle of the second segment of the peduncle; it is about

three and a quarter times as long as wide and the outer margin is straight terminating in a spine which reaches almost to the apex of the lamella.

The mouth parts are illustrated in text-figs. 29a-f. In the mandible the incisor process is comparatively narrow and terminates in four or five teeth. The palp is two-segmented, the basal segment being broadly expanded distally. The outermost of the three portions that compose the first maxilla is bifid at the extremity, each part bearing a single long seta.

The first and second maxillipedes (text-figs. 29d, e) are provided with large epipods; that of the former appendage is bilobed. The third maxillipedes reach beyond

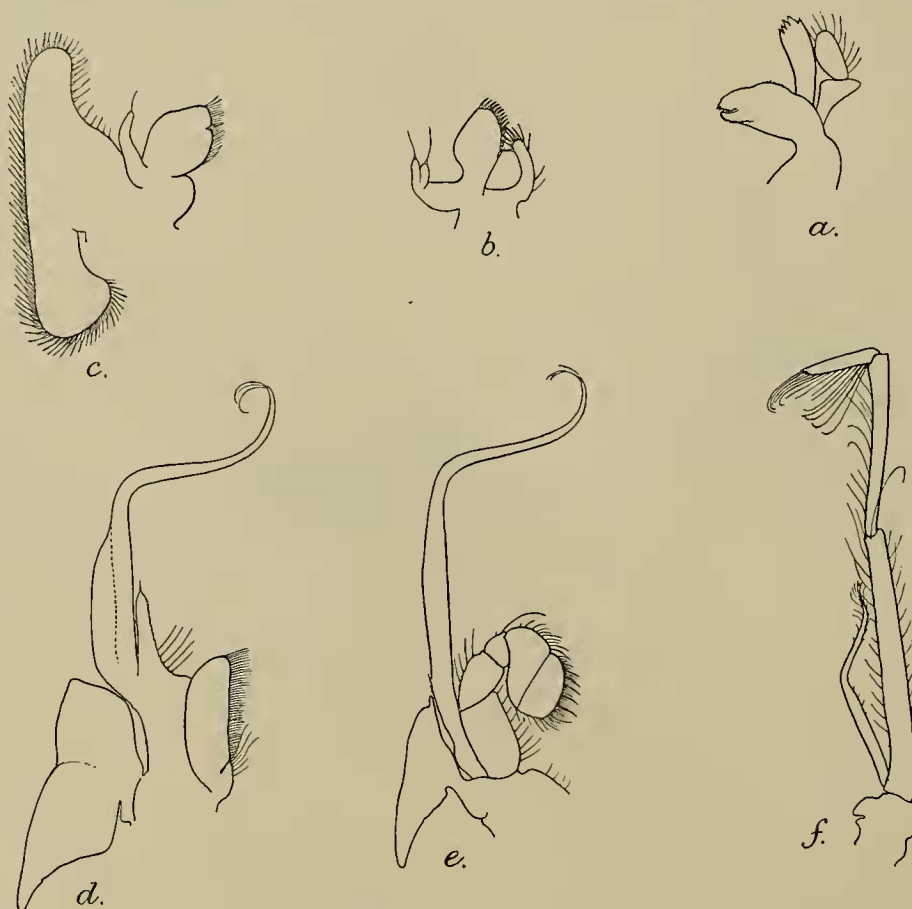


FIG. 29.—*Ogyrides striaticauda*, sp. nov.

- | | |
|--------------------|------------------------|
| a. Mandible. | d. First maxillipede. |
| b. First maxilla. | e. Second maxillipede. |
| c. Second maxilla. | f. Third maxillipede. |

the end of the eyes by the length of the ultimate segment, which is invariably flexed upwards; the exopod reaches nearly to the end of the antepenultimate segment. The long plumose setae which clothe the limb are specially numerous on the ultimate segment, which is rather less than half the length of the penultimate. It will be noticed that the latter segment is much longer proportionately than in any other genus of the family.

The first peraeopods (text-fig. 30a) reach about to the end of the basal segment of the antennular peduncle. The ischium is swollen and, as in *O. sibogae*, is notched inferiorly at the base. The proportional lengths of the ischium, merus, carpus and chela are as 10, 18, 19 and $14\frac{1}{2}$. The fingers are rather less than twice the length of

the palm; they gape slightly at the base when the claw is closed and their cutting margins are entire. Setae are thinly scattered on the lower edges of the ischium and merus¹ and on both margins of the carpus; on the chelae they are more numerous.

The second peraeopods (text-fig. 30b) reach a little beyond the tips of the eyes, the carpus, as in *O. occidentalis* and *O. sibogae*, being composed of four segments. The proportional lengths of ischium, merus, carpus and chela are as 13, 20, 22 and 10. Of the four segments which compose the carpus, the first is very long, nearly one and a third times the length of the three following combined; the second and fourth are nearly equal in length, almost twice as long as the third. The fingers

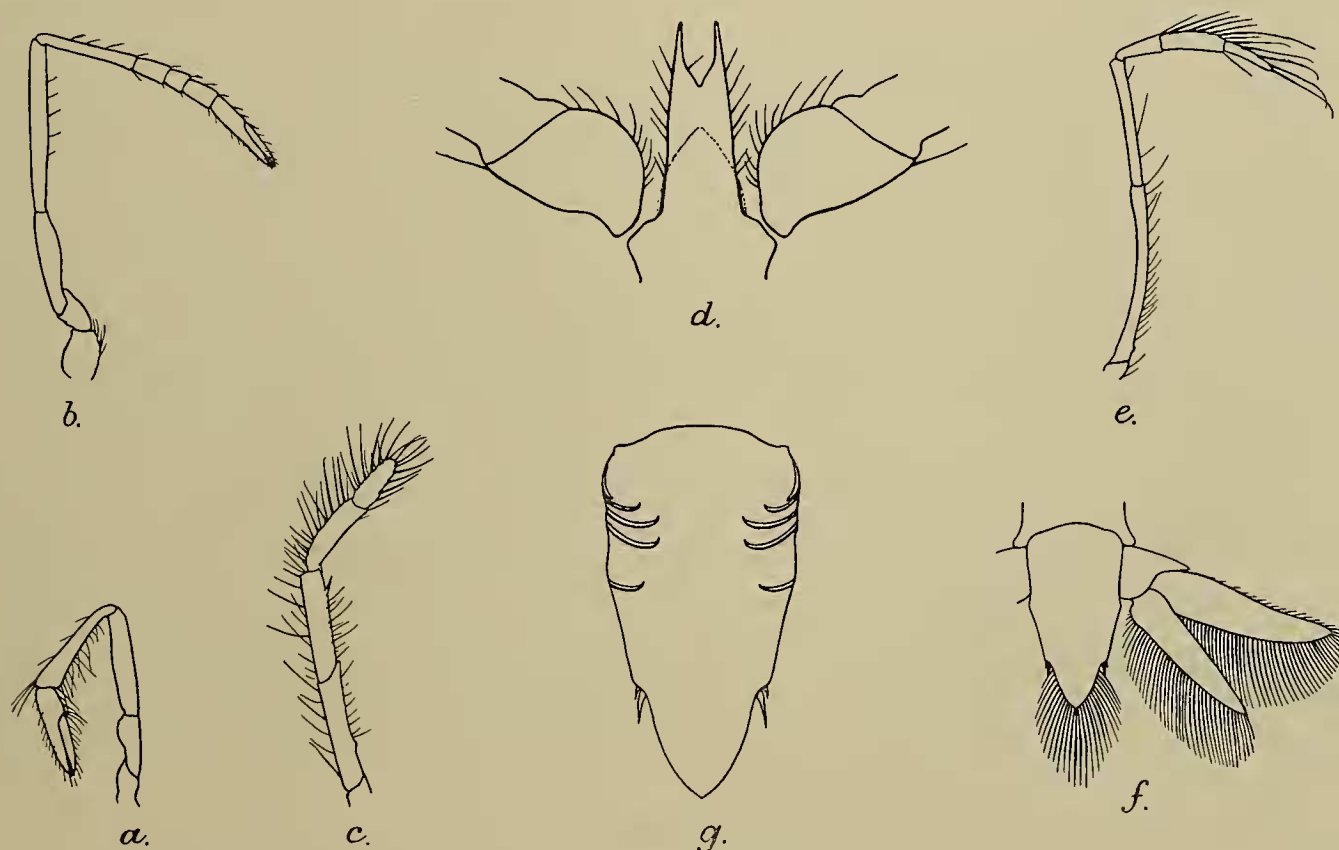


FIG. 30.—*Ogyrides striaticauda*, sp. nov.

- | | |
|----------------------------------|---|
| a. First peraeopod. | d. Sternal process at base of 4th peraeopods. |
| b. Second peraeopod. | e. Fifth peraeopod. |
| c. Third peraeopod. ² | f. Telson and right uropods from above. |
| g. Telson from below. | |

are a little more than one and a half times the length of the palm. The limb bears setae on the distal part of the carpus and on the chela.

Of the last three pairs of peraeopods the fourth is the longest, reaching as far forwards as the first, the third (text-fig. 30c) is the stoutest and the fifth (text-fig. 30e) the most slender. In the third and fourth pairs the dactylus² is very small; the

¹ These are not shown in text-fig. 30a.

² The dactylus of the third peraeopod is not well shown in text-fig. 30c; it is very much more slender than the propodus and about one-third its length, bearing two short setae apically. The figure conveys the erroneous impression that the dactylus is absent and that the propodus bears two long setae, which are crossed, at its apex.

merus of the third bears a stout spine near the distal end of its lower border. All the segments bear setae, most thickly on the carpi and propodi of the third and fourth pairs and on the last two segments of the fifth. The proportional lengths of the ischium, merus, carpus, propodus and dactylus in the third pair are as 16, 14, $9\frac{1}{2}$, 6 and 2: of the same segments in the fourth pair as 16, 23, 11, 10 and 2: of the same segments in the fifth pair as $22\frac{1}{2}$, 15, $5\frac{1}{2}$, $7\frac{1}{2}$ and $5\frac{1}{2}$. Attached to the proximal segments of the fourth pair of legs is a curious elongated plate (text-fig. 30d) which extends forwards to the base of the third pair, lying close to the sternum. The lateral margins of this plate are straight, a little convergent distally, and its apex is deeply bifurcated.

The abdominal somites are smooth above; their pleura are rounded inferiorly. The length of the sixth somite is about equal to that of the fifth.

The telson is a little longer than the sixth somite and is shorter than both inner and outer uropods; it is slightly sulcate above and bears two pairs of small dorsal spinules (not shown in text-fig. 30f). At the distal end of each lateral margin are two pairs of spines and the apical portion between them is produced and at the extremity rather sharply angled. The innermost pair of spines, which is much the longest of the two, reaches to less than half the length of the produced median part. The breadth at the level of the spines is a little more than one-third the total length. The telson does not possess a feeble lateral prominence but on either side, situated in the proximal third and on the ventral surface, are four oblique ridges, the three anterior ones placed close together, the other rather more distant. The arrangement of these ridges, which appear to be characteristic of the species, is shown in text-fig. 30g. In spirit specimens they have a nacreous lustre and perhaps represent a stridulating organ, but I am unable to find that they possess transverse striae and there does not appear to be any ridge on the basal segment of the uropods which could be brought to bear upon them.

The outer uropod (text-fig. 30f) is longer than the inner; it is distally pointed, setose on both margins and about three and a half times as long as broad.

The largest specimen, an ovigerous female, is about 14 mm. in length.

A synoptic key and references to the four hitherto known species of the genus is supplied by de Man.¹ *O. striaticauda* is evidently a very close ally of *O. occidentalis*, Ortmann², from the mouth of the Tocantins River in Brazil. Ortmann's description is very brief and neither in it nor in the figures is there any indication of the ridges found on the telson in the Indian species; it is probable, therefore, that a well-marked difference exists in this respect between the two forms. In *O. occidentalis*, also, the eyes do not extend beyond the antennular peduncle and, according to the figures³, the antennal scale is considerably longer than in *O. striaticauda*, the basal

¹ De Man, *Decap. 'Siboga' Exped.*, II, *Alpheidae*, p. 135 (1911).

² Ortmann, *Decap. Schizop. Plankton-Exped.*, p. 46, pl. iii, figs. 4, 4a-z. (1893).

³ The figures are perhaps not very reliable. That of the third leg at least is almost certainly erro-

segment of the mandibular palp is not widened distally, the exopod of the outer maxillipedes is much shorter, the three distal subsegments of the carpus of the second legs are of equal length and the telson is narrower, with the apex evenly rounded.

Living specimens of *O. striaticauda* were for the most part transparent, the greenish visceral and hepatic masses being clearly visible through the walls of the carapace. The eyestalks, antennules and antennae were pale red and the oral appendages, maxillipedes and first two pairs of legs bright red. On the first abdominal somite there were two transverse rows of red pigment spots and one similar row on each of the succeeding somites. The pleural margins were also red and the eggs borne by the ovigerous female were bright green.

O. striaticauda is apparently very scarce in the Chilka Lake: in all, only eight specimens were obtained. They were found in the outer channel in March, when the water was as salt as that of the sea outside the lake area, and in September, when it was entirely fresh. Three individuals were caught on the clean sandy bottom between Manikpatna and the mouth of the lake in company with *Pontophilus hendersoni*, while the remainder were obtained on the muddy ground in the vicinity of Barhampur I. No specimens were met with in the main area of the lake. The ovigerous female was found in March in salt water.

In addition to the Chilka lake specimens, there are in the Indian Museum numerous other examples obtained by Mr. F. H. Gravely in September 1914, in the Cochin backwaters near Ernakulam. There are ovigerous females among these specimens, though none were found at the same time of the year in the Chilka Lake. A few specimens were also taken in the Ennur backwater in January 1915, by Dr. Annandale. They were living on a bottom of almost pure sand in water of very low specific gravity. One female bore eggs.

Genus *ATHANAS*, Leach.

1899. *Athanas*, Coutière, *Ann. Sci. nat., Zool.* (8), IX, p. 323.

Among the species of this genus most marked differences exist in the degree of development of the first pair of legs. In most forms those of the male are greatly enlarged, much as in the genus *Alpheus*, and may be symmetrical or asymmetrical. In females the first legs may resemble those of the male, or one or both limbs may be small and slender.

In the species of *Athanas* found in the Chilka Lake the first pair of legs presents features of unusual interest and it seems desirable therefore, in the first place, to summarise our knowledge of the development of these limbs in the various forms that have been described.¹

neous, for Ortmanu has apparently failed to discern the true division between the merus and ischium and has represented what is really the produced lower distal angle of the latter as a spine at the base of the former.

¹ A most valuable key to the species of *Athanas* has been supplied by de Man, *Decap. 'Siboga' Exped.*, II, *Alpheidae*, p. 146 (1911).

Species.	First pair of peraeopods.	
	Male.	Female.
Group of <i>A. nitescens</i> .		
<i>A. nitescens</i> , Leach ..	Asymmetrical, both enlarged ..	Asymmetrical, one only a little enlarged.
<i>A. naijaroensis</i> , Coutière ..	Unknown	Symmetrical, not greatly enlarged.
<i>A. aretiformis</i> , Coutière ..	One enlarged, the other unknown ..	One not greatly enlarged, the other unknown.
<i>A. grimaldi</i> , Coutière ..	Symmetrical, enlarged ..	Symmetrical, enlarged.
<i>A. granti</i> , Coutière ..	Asymmetrical, both enlarged ? ..	Asymmetrical, both enlarged ?
<i>A. parvus</i> , de Man ..	Unknown	Symmetrical, not enlarged.
Group of <i>A. dimorphus</i> .		
<i>A. dimorphus</i> , Ortmann ..	Symmetrical, enlarged ..	Symmetrical, not enlarged.
<i>A. minikoensis</i> , Coutière ..	Asymmetrical, both enlarged ..	Asymmetrical, one only enlarged.
<i>A. haswelli</i> , Coutière ..	Unknown	One (? both) not enlarged.
<i>A. orientalis</i> , Pearson ..	Unknown	Asymmetrical, one only enlarged.
<i>A. djiboutensis</i> , Coutière ..	Asymmetrical, both enlarged ..	Asymmetrical, one only enlarged.
<i>A. sibogae</i> , de Man ..	Asymmetrical, both enlarged ..	Asymmetrical, both enlarged.
<i>A. jedanensis</i> , de Man ..	One enlarged, the other unknown ..	Symmetrical, not enlarged.
<i>A. tenuipes</i> , de Man ..	Unknown	Unknown.

The single species of *Athanas* found in the Chilka Lake belongs, apparently, to a form hitherto unknown, but is closely allied to Ortmann's *A. dimorphus*. It was unfor-

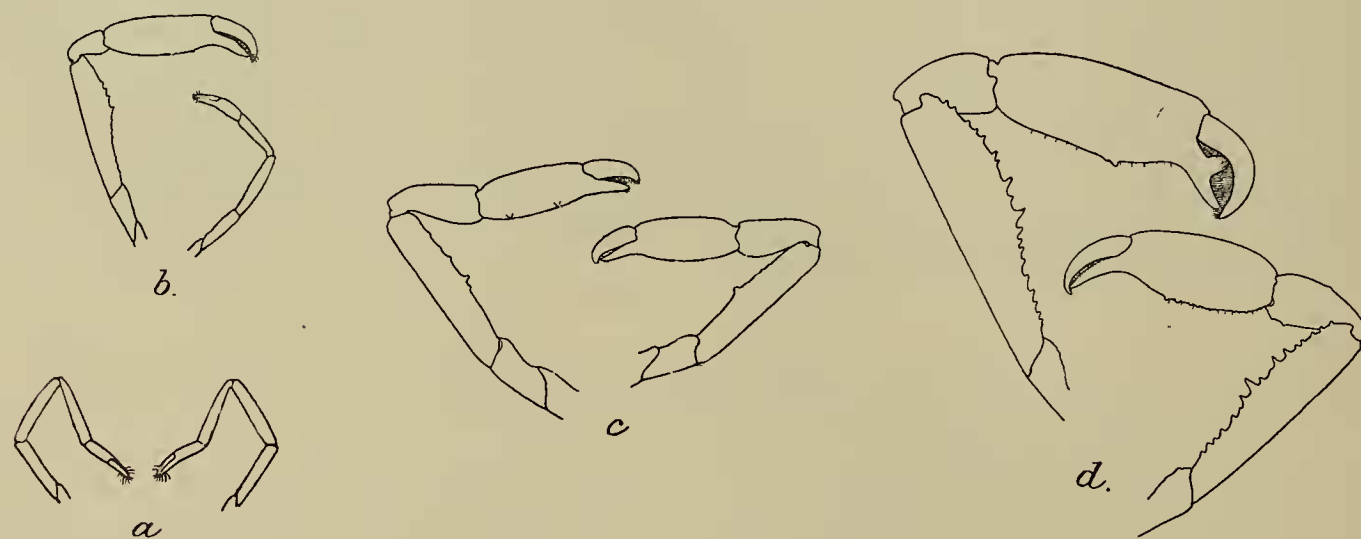


FIG. 31.—*Athanas polymorphus*, sp. nov.

a. First peraeopods of female. c. First peraeopods of male, form II.
b. do. of male, form I. d. do. of male, form III.

unately very scarce, and of the twenty-seven specimens obtained only nine are males. These nine males, however, present a most notable diversity of form, a fact which has led me to assign to the species the name *Athanas polymorphus*.

As in *A. dimorphus* the first legs in the female are both slender (text-fig. 31a), with the carpus longer than the chela and are wholly dissimilar in structure from the large limbs of the male. But, apart from this feature, which evidently influenced Ortmann in his choice of a specific name, the males in the new species can be separated into three clearly defined groups according to the degree of development which

the first legs have attained. In the smallest males (five specimens) one of the first legs, either right or left, is identical in structure with that of the female, while the other is greatly enlarged, the fingers of the chela being curved and not provided with teeth (text-fig. 31*b*). In other males (two specimens) both legs of the first pair are equally enlarged, each being closely similar to the large limb borne by the preceding form (text-fig. 31*c*). In others again (two specimens) both legs are enlarged, but asymmetrical; one limb, except for the greater number of spines on the merus, is similar to that in the preceding group, while the other is a little larger and, apart from more trifling differences in forms, is provided with a huge rounded tooth on the fixed finger (text-fig. 31*d*).

The characters of the nine males may be tabulated thus:—

Date of capture.	Length of carapace. ¹	First peraeopods.
1914.	mm.	Form I, text-fig. 31 <i>b</i> .
Sept. 9th	2.6	Asymmetrical. One, either right or left, enlarged, without tooth on fixed finger and with few spines on merus. Other slender, of proportions similar to those of female.
Sept. 10th	2.5	
	3.2	
Sept. 12th	2.8	
	2.3	
March 22nd	5.0	Form II, text-fig. 31 <i>c</i> .
	4.3	Symmetrical. Both enlarged, without tooth on fixed finger and with few spines on merus.
March 16th	4.4	Form III, text-fig. 31 <i>d</i> .
	4.1	Asymmetrical. Both enlarged, with numerous spines on merus. Right leg in both specimens with large rounded tooth on fixed finger. Left, in one specimen without tooth on finger (<i>i.e.</i> similar except for spines on merus to Form II), in the other specimen missing.

In all these specimens the appendix masculina on the second pleopods is well developed; there is thus no doubt regarding their sex. Also, it is in my opinion impossible that the small limb found in Form I is the result of regeneration. In almost all cases it is easy to distinguish a limb that has been broken off and subsequently grown again and it is, I think, inconceivable that in each of the five individuals of this form it should be equally and perfectly re-developed.

The case therefore is one of trimorphism, at any rate in a somewhat loose application of that term; but the specimens are so few in number that I have found it

¹ The measurement is taken from the posterior mid-dorsal edge of the carapace to the tip of the eye.

impossible to do more than make a few suggestions, some perhaps rather more probable than others, to account for the existence of this curious phenomenon.

It will be seen from the table given above that the largest and most fully developed specimens, Forms II and III, were caught in March, while all belonging to Form I are smaller and were obtained in September. The breeding season is apparently in March, for it was only in this month that ovigerous females were found. Judging by its size, Form I is probably the youngest and may represent a non-breeding phase; but it would be very extraordinary if the three forms were merely stages in the life-history of the species. In very young males, perhaps early post-larval forms, it is probable the first limbs are both slender, resembling those of the female and, if Forms I, II and III represent successive stages in growth, the development is, as far as I am aware, without parallel. On this theory the young male would, in the course of a few months, develop one enlarged limb, the pair being greatly asymmetrical (Form I). Later, at a subsequent moult, the other limb would be similarly enlarged, the pair thus becoming symmetrical (Form II), while still later asymmetry would again be manifest in the form of the chelae, the spines on the merus being increased in number in both limbs. According to this theory the males could not strictly speaking be regarded as trimorphic, the case would merely be one of a most unusual post-larval metamorphosis.

Another and perhaps rather more plausible suggestion may be made. The males may be strictly dimorphic, Forms II and III each representing the ultimate development in the life of an individual, each being a fixed type which never alters in the course of subsequent moults. On this theory Forms II and III would be developed simultaneously at the beginning of the breeding season from the non-breeding phase represented by Form I.

One more theory remains. The males may be strictly trimorphic, each of the three forms representing a fixed and unalterable type, predetermined perhaps from an early age. The facts available regarding the size and date of capture of the specimens seem to indicate that this view has but little to recommend it.

The three suggestions which have been made must, I think, exhaust all probable explanations of the case, for it is impossible that the three forms merely represent items in a series exhibiting normal variation. My suggestions may be summarised thus:—

Theory I. That the three forms of male represent merely so many stages in the life-history of this sex of the species.

Theory II. That the males are truly dimorphic, Forms II and III representing unalterable types developed simultaneously at the breeding season from the non-breeding Form I.

Theory III. That the males are truly trimorphic, each of the forms representing a type unalterable in the life of the individual.

At first glance it seems possible to find an analogy between the three forms of male in *Athanas polymorphus* and the three forms of the same sex known in certain

Oxyrhynch crabs; but it does not seem probable that the two cases are really identical, though in both it is the development of the first legs that is concerned.

According to Geoffrey Smith's investigations¹ three types of males are to be found in some species of Oxyrhyncha and he names these three types "low," "middle" and "high." In both low and high males the chelae are swollen, there being a marked difference between the two groups in the comparative size of the limbs. The chelipedes of the middle form are, on the contrary, scarcely swollen at all, resembling those of the females. The low males are smaller than the high and the middle intermediate in size. During the breeding seasons the majority of the males that are found belong to the low or high forms, while in the intervening seasons middle males predominate. The low male in the course of its development to the high form passes through a middle stage in which the sexual function is in abeyance.

The investigations made by Hagen² and Faxon³ on American crayfish referred to *Cambarus* have brought to light the fact that in this genus there are two forms of male, distinguished by the shape of the first abdominal appendages, and it has been shown that these two forms represent breeding and non-breeding phases. An almost precisely similar phenomenon has been noticed by Wollebaek⁴ in one of the Pandalidae, *Pandalus montagui* (= *annulicornis*), though it apparently does not occur in allied species of the genus.

It is evident that these two last instances, although the organs concerned are more directly connected with the sexual function, belong to the same category as that of the Oxyrhynch crabs, in which the peculiarities are shown in the chelipedes. Although phenomena of the kind seem to be rare in the Decapods, it is clear that instances of a seasonal sexual dimorphism occur in at least three widely separated groups of the order, viz. the Caridea, Nephropsidea and Oxyrhyncha.

True dimorphism, i.e. the "definitive dimorphism" of Smith, is well known in many insects; but, if it ever exists, is of extremely rare occurrence among Decapoda.⁵ Henderson and Matthai⁶ have, indeed, brought forward facts which seem to indicate that the Palaemonidae known as *Palaemon scabriculus*, *P. dolichodactylus* and *P. dubius* are in reality true trimorphic forms of a single species, differing from one another in the proportionate measurements of the large claws of the male. Further evidence is, however, necessary before this view can be accepted as definitely proved.⁷

It appears to be impossible to bring the case of *Athanas polymorphus* into line with any of these instances. That the males show a definitive trimorphism is, I

¹ Smith, *Mitth. zool. Stat. Neapel*, XVII, p. 312 (1905).

² Hagen, *Ill. Cat. Mus. Comp. Zool.* II, pp. 20, 21 (1870).

³ Faxon, *Mem. Mus. Comp. Zool.*, X, 4, p. 12 (1885).

⁴ Wollebaek, *Bergens Museums Aarbog*, 1912, No. 8, p. 64.

⁵ See my paper in *Rec. Ind. Mus.*, X, pp. 84-87 (1914) for a criticism of the supposed dimorphism in certain Hippolytidae and Palaemonidae.

⁶ Henderson and Matthai, *Rec. Ind. Mus.*, V, p. 280 (1910).

⁷ A definitive dimorphism is of course well known in Crustacea other than Decapods.

believe, most improbable, for the specimens of Form I were not obtained during the breeding season and in the non-breeding season occurred apparently to the exclusion of Forms II and III. It is clear, too, that the instance is not merely one of a seasonal sexual dimorphism such as occurs in *Cambarus* and *Pandalus*, though this may in part account for the peculiarities which have been noted.

On the evidence which I am able to offer, a parallel with the Oxyrhynch crabs also cannot be maintained, for Form I, which approximates most nearly to the female and might therefore be regarded as the representative of Smith's "middle" crabs, is not intermediate in size between Forms II and III, nor do these last forms show the marked difference in dimensions that one would expect if they corresponded respectively to the "low" and "high" forms in the Oxyrhynchs. Similarly it is impossible to regard the specimens of Form II as "middle" individuals: the measurements do not tally and the examples were found during the breeding season, at which time Form I was apparently absent.

The widespread though rare occurrence of a seasonal sexual dimorphism in the Decapoda suggests that this phenomenon will afford a partial explanation of the three forms of male in the Chilka species of *Athanas*. Form I, even though the appendix masculina is to all appearances fully developed, is probably a non-breeding phase of the sex. It is likely, on the other hand, that Forms II and III are breeding phases and, from the scanty evidence available, it seems reasonable to regard them as definitive dimorphic forms. This theory, the second of those listed on p. 292, appears to me the most plausible of any.

With further material it will be possible to determine if it is correct, and we may also be able to discover if Form I comprises specimens which have never bred or is a phase of a form that was once sexually active. From the specimens available it seems on the whole most probable that the former explanation is the true one and that males of Forms II and III perish at the close of the breeding season.¹

The knowledge of the existence of three distinct forms of male in *Athanas polymorphus* must, I believe, have a marked effect on our views as to the systematic treatment of the genus, for it is not unlikely that different forms of the same species have been described under separate names.

I am inclined to think, also, that sufficient care has not been taken in determining the sex of the specimens described. When two forms of a species are found, that with the most highly developed limbs is considered to be the male and the other the female. Even Dr. de Man in his account of *Athanas sibogae* describes a specimen which "is considered to be the female of this species, with some doubt, because it carries no eggs"; it is not improbable that this example is really a second form of the

¹ Eventually it may perhaps be possible to find some analogy between the phenomena found in *Athanas* and those discovered by Sewell in Copepoda. Sewell, in tracing the development of certain species of this group by the application of "Brooks' Law", has found that in the male there may be two definitive dimorphic forms, both mature. Individuals of stage IV of Sewell's terminology may develop directly into the "low" form or, with the intervention of an additional immature stage, may reach the "high" form. See Sewell, *Rec. Ind. Mus.*, VII, p. 316 *et seq.* (1912).

male. In the determination of the sex it is essential that the second pleopods should be examined to ascertain whether the appendix masculina is present or absent.

There is one other point of more than systematic interest in the specimens of *Athanas* found in the Chilka Lake, and this concerns the development of the second pair of legs. The carpus of these limbs in *Athanas* is composed of five sub-segments, whereas in the allied genus *Arete* there are only four. In twenty-three specimens of *Athanas polymorphus* the carpus is on both sides composed of five sub-segments and has a similar development in the single limb of the pair which alone persists in two additional specimens. The two remaining examples are, however, abnormal. In one of them, a male belonging to Form I, the carpus on one side is five-, and on the other four-segmented, while in the other specimen, which is a female, both the carpi are composed of only four segments (text-fig. 32e). The last specimen, if it had been taken alone, would almost certainly have been described as a new species of *Arete*, bearing a close resemblance to *Athanas*.

It is, however, through the *nitescens* group of *Athanas* that Coutière would derive *Arete* and not through the *dimorphus* group to which the Chilka species belongs.

Athanas polymorphus, sp. nov.

The rostrum is without teeth and reaches almost to, or a little beyond the end of the second segment of the antennular peduncle. In two large males (those belonging to Form III) it has evidently suffered injury and is abruptly curtailed at the apex, reaching only to the middle or end of the basal antennular segment. The dorsal carina of the rostrum extends backwards and is visible in the anterior sixth of the carapace. The supra-corneal spine is entirely absent; the extra-corneal is well developed, reaching to about half the length of the eye. The infra-orbital angle ("dent infra-cornéene" of Coutière) is small, but acute, though less spinous in character than the extra-corneal. There is also a sharp tooth opposite the insertion of the antennae, absent in *A. dimorphus*, which must, I think, be the homologue of the pterygostomian spine (text-figs. 32a, b).

The eyes are small, but well pigmented. The antennular peduncle reaches to the apex of the rostrum. The basal segment is little longer than the second and on its infero-internal margin bears, as is usual, a well-marked longitudinal crest, which terminates anteriorly in a tooth reaching almost to the distal end of the segment. The lateral process (stylocerite) is composed of a long spine which extends only a little beyond the end of the segment. The second segment is about one and three quarter times as long as the third. The inner antennular ramus is longer than the outer: the latter is distally bifid and the thicker of its branches, which is much the shorter, is about as long as the peduncle. The fused part is composed of from 8 to 10 segments and the free portion of the outer and thicker of the two branches is from one half to three quarters its length.

The carpocerite reaches almost to the end of antennular peduncle. The anten-

nal scale (text-fig. 32c) is from 2.4 to 2.5 times as long as wide and the straight outer margin terminates in a sharp spine which reaches to, or a trifle beyond, the broad apex of the lamella.

The outer maxillipedes reach to the end of the second segment of the antennular peduncle and possess an epipod "en crochet." The terminal segment is stouter than the penultimate and is about one and three quarter times its length.

The first peraeopods of the female are both slender, as in *A. dimorphus*, and, if extended, would reach about to the end of the antennal scale; in both sexes they are, however, habitually flexed at the carpo-meral joint. In the female the legs of this pair are equal, or very nearly so, the carpus and ischium are almost equal in length, the merus sometimes just a trifle longer. The chela is about three-quarters the length of the carpus and the fingers are as long as the palm. The segments are

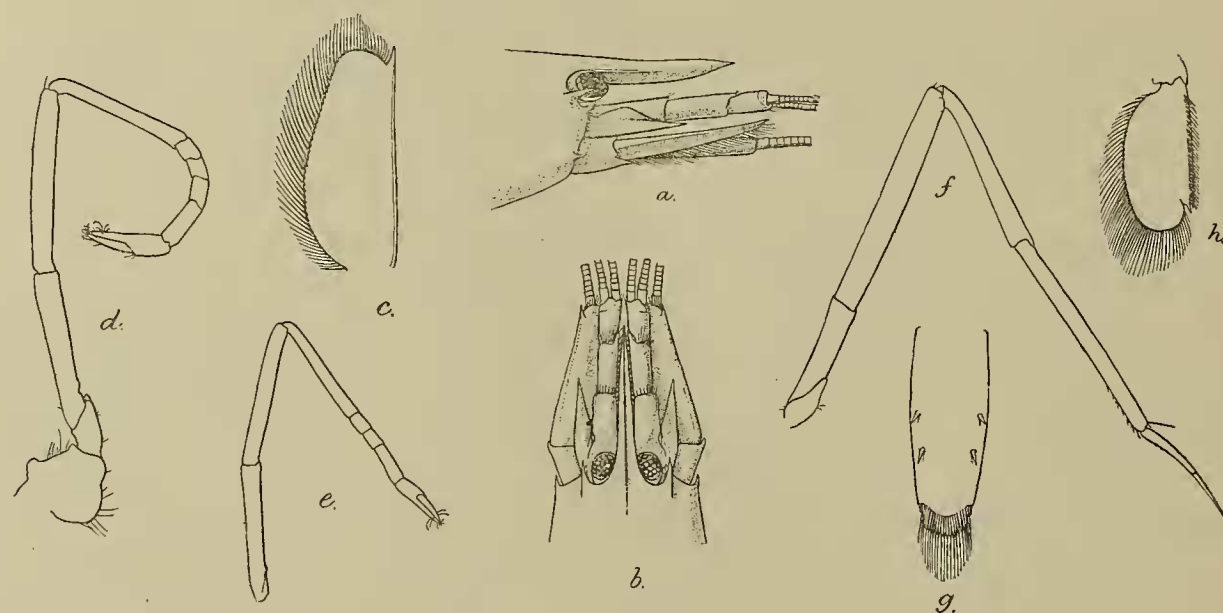


FIG 32.—*Athanas polymorphus*, sp. nov.

- | | |
|---|---|
| a. Anterior part of carapace, rostrum, etc., in lateral view. | e. Second peraeopod with abnormal segmentation. |
| b. do. in dorsal view. | f. Fifth peraeopod. |
| c. Antennal scale. | g. Telson. |
| d. Second peraeopod. | h. Outer uropod. |

devoid of spines and, except for a few hairs on the fingers, are glabrous (text-fig. 31a).

In males, as has already been explained (p. 291) the legs of the first pair are of three types. In Form I (text-fig. 31b) the limbs are very asymmetrical, one resembling that of the female, while the other is greatly enlarged. The slender limb differs, however, from that of the female in its proportional measurements, the merus being almost one-third longer than the carpus, while the chela is scarcely shorter than the latter segment. The large leg of Form I is very different in structure; the ischium is quite short and the merus large with its outer lower edge dilated, forming a sort of recess into which the chela fits when the limb is folded. The merus is about five times as long as broad and is only a trifle shorter (as 18 to 19) than the

greatly enlarged chela ; on its inner edge is a series of small teeth, varying in size, but for the most part ill-developed. The carpus is very short, about two-sevenths the length of the merus, and its breadth is about half its length. The chela is about four times as long as broad ; the palm is 2.7 times as long as broad and about twice the length of the dactylus. In front of its middle point, on the antero-internal aspect, there are usually one or two small tubercles. The fingers are without teeth on their cutting edges ; the dactylus is strongly curved and longer than the fixed finger, which is nearly straight and bluntly pointed apically.

In males of Form II (text-fig. 31c) the first peraeopods are symmetrical, or nearly so, each being similar to the large limb of Form I. The merus in the specimens of this form is a little longer than the chela and is less expanded than in Form I, being 5.4 times as long as broad. The carpus is longer, fully half the length of the merus, while the chela has much the same proportions, but is a little broader, about three and one third times as long as wide. A tubercle is sometimes seen on the antero-internal aspect of the palm and there are a few spines on the inferior margin of the merus.

In Form III (text-fig. 31d) the legs of the first pair are asymmetrical, though both are much enlarged. In both limbs the spines on the border of the merus are more numerous and better developed than in Forms I and II and there may also be small tubercles on the carpus and a series on the inner face of the palm. The smaller limb bears a close resemblance to those found in Form II. The merus is 4.7 times as long as wide, the carpus is a little less than half its length and is about twice as long as broad. The chela is about three times as long as broad and the dactylus is more than half the length of the palm. In the larger limb the merus is similar, 4.6 times as long as wide, while the carpus is distinctly shorter, about one-third the length of the merus. The chela is a little shorter than the merus and about three times as long as broad. The fixed finger differs conspicuously from that borne by the leg on the other side of the animal in the possession of a large rounded tooth or lobe near the middle of its inner margin.

The second peraeopods (text-fig. 32d) are folded like those of the first pair, being flexed at the mero-carpal articulation. The merus is a little longer than the ischium ; the carpus is almost one and a half times the length of the merus and is fully three times as long as the chela. The carpus in all except two individuals is composed of five sub-segments: the first is much the longest, almost three times the length of the fifth, and the second, third and fourth are subequal and but little longer than broad, each being about half the length of the fifth. The dactylus is a little longer than the palm. As noted above (p. 295) the carpus in one male belonging to Form I is, on one side only, composed of four sub-segments, while in one of the females each limb of this pair has a similar development. The reduction in number is apparently brought about, in these abnormal individuals, by the fusion of the two proximal segments (text-fig. 32e).

The last three pairs of peraeopods are similar ; their segments are devoid of spines and their dactyli are simple, not biunguiculate as in certain other species of

the genus. The third pair, which is the longest, reaches beyond the apex of the antennal scale by the length of the dactylus; the fifth reach almost to the end of the second segment of the antennular peduncle. In the third pair the carpus is a little longer than the propodus, nearly one and a half times the length of the ischium, and about three quarters as long as the merus. The latter segment is eight times as long as broad. The dactylus is slender, slightly curved, and terminates in a very fine claw which is nearly as long as the segment proper. The propodus is about 1.7 times the entire length of the dactylus.

In the fifth peraeopods there is a series of setae, not found on the two preceding pairs of limbs, at the distal end of the propodus on its inferior surface. The carpus is one-fifth shorter than the propodus, the latter segment being about equal in length with the merus. The merus is eight times as long as wide and about twice the length of the ischium; the dactylus has the same proportion to the propodus as in the third leg (text-fig. 32f).

The branchial formula is apparently the same as in other species of the genus; epipods "en crochet" (epipod α of Coutière's terminology) are present on the first three peraeopods.¹

The abdominal pleura are rounded, except for that of the fifth somite, which is acutely pointed behind, and for the posterior angle of the sixth, which is also acute and articulated as in other species of *Athanas*.

The appendix masculina is well developed in all the males and is about the same length as the appendix interna.

The telson (text-fig. 32g) is as long as the uropods. It is a little less than four times as long as the breadth between the posterior angles and bears two pairs of dorso-lateral spinules. The margin between the two pairs of postero-lateral spinules is gently rounded and fringed with long setae, each seta being markedly swollen at the base. The inner of the two pairs of spinules is more than twice as long as the outer, both extending beyond the apex of the median portion. The outer uropod (text-fig. 32h) bears a fringe of setae on the under side, running parallel with, and close to, the external margin; it is a little more than twice as long as broad.

A large male is only about 15 mm. in total length; the ovigerous females do not exceed 13 mm.

Athanas polymorphus is evidently closely allied to Ortmann's *A. dimorphus*² and would find a place next that species in the admirable key which de Man has provided (*loc. cit.*, p. 289, footnote). Both sexes of the Chilka Lake species are readily distinguished from *A. dimorphus* by the presence of a spine near the antero-lateral angle of the carapace, while males may be separated at a glance by the spines on the inferior edge of the merus in the enlarged first leg. From all other species in the same section of the genus it is distinguished by the great length of the carpus in the first legs of the female.

¹ See Coutière, *Ann. Sci. nat., Zool.* (8), IX, pp. 276, 277 (1899).

² Ortmann, in *Semon's Zool. Forschungsreis. in Australien, etc.*, V, p. 12, pl. I, fig. 1 (1894).

The species is beautifully coloured in life. The entire animal is very closely dotted with large maroon chromatophores, the gastric and hepatic regions sometimes showing faintly through the carapace as reddish or greenish masses. The following conspicuous patches of cream or lemon yellow occur:—a transverse bar, sometimes merely a spot, situated dorsally in the middle of the carapace and another, always well marked, at the posterior end of the carapace, occupying three-quarters of its breadth in dorsal view; a large spot on either side of the first abdominal somite; a similar spot on the second somite, with another lower down near the pleural margin, and a large mid-dorsal patch or transverse streak; a transverse band on the third somite and a large pleural spot; a similar band on the fourth somite, rarely broken into three patches. The fifth somite is maroon, rarely with a pair of small cream-coloured spots posteriorly, and the posterior half of the sixth is entirely lemon yellow or cream. The tip of the telson is sometimes cream, sometimes undifferentiated. The antennules and antennal scales are often maroon, resembling the other parts of the animal, or, in paler individuals, faintly mottled or wholly transparent. All the maxillipedes and legs are transparent with a slight purplish tinge. The eggs are very dull sage green.

When walking *A. polymorphus* used only the last three pairs of legs, the first two pairs being folded beneath the carapace. The antennules were held straight forwards and the antennae at right angles.

The species is described from twenty-seven specimens, eighteen females and nine males. Of the latter five are of Form I, two of Form II and two of Form III. All were obtained in the outer channel off Satpara and Barhampur I. on a muddy bottom at depths ranging from 6 to 10 ft. Examples were caught both in March, when the water was as salt as that of the Bay of Bengal near the lake, and in September when it was quite fresh. In the latter month only males of Form I and non-ovigerous females were found, whereas in March the males obtained belonged either to Form II or to Form III and three of the females were bearing eggs.

Genus **ALPHEUS**, Fabricius.

Alpheus crassimanus, Heller.

1865. *Alpheus crassimanus*, Heller, *Crust. 'Novara'—Reise*, p. 107, pl. x, fig. 2.

1888. *Alpheus crassimanus*, Bate, *Rep. 'Challenger' Macrura*, p. 554, pl. xcix, fig. 2.

1898. *Alpheus lobidens*, Coutière, *Notes Leyden Mus.*, xix, p. 199.

1899. *Alpheus crassimanus*, Coutière, *Ann. Sci. nat., Zool.* (8), ix, p. 239, text-fig. 293.

1902. *Alpheus crassimanus*, de Man, *Abhandl. Senckenb. Ges. Frankfurt*, XXV, p. 880, pl. xxvii, fig. 62.

1911. *Alpheus crassimanus*, de Man, *Rep. 'Siboga' Decap.*, II, *Alpheidae*, p. 417.

The characters on which I have relied for the identification of this species are the following:—

The rostrum reaches to a point midway between the margins of the orbital hoods and the end of the first antennular segment. It extends backwards nearly to the

base of the hoods as a thin well-marked crest (not flattened above) and is rendered the more conspicuous by the comparatively deep depressions which exist on either side of it. The dorsal edge, which is, as a rule, a little concave, is concealed in lateral view by the rather elevated eye-hoods.

The dactylus of the smaller chela of the male is subspatulate in form, "Balaeniceps"-shaped; in the female the dactylus of this chela is slender. In both limbs and in both sexes there is a sharp spinule at the distal end of the infero-internal margin of the merus, while there is no tooth on either side of the insertion of the dactylus.

In the large chela the depressed area on the supero-internal face is triangular in shape and the lobes on the upper and lower margins of the palm are distally rounded (not acutely produced). The small chela of the male is scarcely, if at all, more than three and a half times as long as wide and the palm is distinctly notched, both dorsally and ventrally, behind the fingers.

The merus of the third legs is without teeth and is rather less than five times as long as wide. The dactylus of the last three pairs of legs is simple.

The specimens which possess these characters were found among clumps of oysters in the outer channel of the lake and agree very closely with de Man's detailed description (*op. cit.*, 1902). When the antennule is dissected out, the second peduncular segment proves in reality to be but little longer than the first, though, if the measurements be taken along the inner edge, the former is, as in de Man's account, about one and a half times the length of the latter. In the large chela the total length is from 2.1 to 2.3 times the greatest width, the claw being therefore rather broader than in the specimens examined by de Man in which the same proportion varies from about 2.3 to 2.45.

Other examples found under rocks at the south end of the main area of the lake differ rather notably from those obtained in the outer channel, but must, I believe, be referred to the same species. In all these specimens the rostrum is less sharply carinate than in the others and the grooves on either side of it are broader and shallower. The large chela also is narrower—a difference readily noticed without measurement—the length being from 2.4 to 2.48 times the greatest breadth. In other respects these individuals agree with those from the outer channel.

Dr. de Man, when examining the 'Siboga' material of this species, notes that two specimens from a single locality differ notably from the remainder in having stouter limbs, and it is probable that phases showing more or less distinct minor characteristics, presumably adaptational, are to be found in different regions. The occurrence of two such phases in the Chilka Lake is of no little interest, owing to the close proximity of the localities in which they were found and to the wide differences in environment.

The form obtained in the outer channel lives among clumps of oysters, practically always submerged; the water, during some nine months of the year, is as salt as that of the Bay of Bengal outside the lake (sp. gr. 1.0265), while for the other three it is almost entirely fresh. The form occurring at the south end of the main area is subjected to much less violent changes in salinity and lives under stones and

boulders, which under certain conditions of flood, tide and wind are above water-level. According to our observations the specific gravity of the water in this part of the lake varies from 1.006 to 1.015. Our collections show that the species occurs in both localities throughout the year.

Ovigerous females were found at the south end of the main area in March and, on the oyster beds in the outer channel, in September and December. The eggs are a little more than .5 mm. in diameter. The largest individual is about 36 mm. in length.

An individual from Rambha Bay was, in life, of a dull greenish colour with darker green markings on the large chela; there was also a small black spot on each side of the second and fourth abdominal somites. In the large chela the tips of the fingers are pink.

This species does not construct an elaborate burrow, although when found under stones on soft mud it appeared to have excavated a short horizontal tunnel, probably never more than a few inches in length. The sound made by the species is very loud and we frequently heard it when walking near the places in which specimens were living.

Alpheus crassimanus is known to have a distribution extending from Djibouti to Celebes.

Alpheus malabaricus, Fabricius.

1798. *Alpheus malabaricus*, Fabricius, *Ent. Syst. Suppl.*, p. 405.

1893. *Alpheus malabaricus*, Henderson, *Trans. Linn. Soc., Zool.* (2), V, p. 434, pl. xl, figs. 1-3.

1911. *Alpheus malabaricus*, de Man, *Rep. 'Siboga' Decapoda*, II, *Alpheidae*, p. 330 (in key to species).

In his account of the 'Siboga' Alpheidae de Man recognises two varieties of this species, var. *dolichognathus*, Ortmann, and var. *leptopus*, de Man, and the characters by which these three forms are differentiated are shown in his key.

The specimens from the Chilka Lake unquestionably represent the typical form of the species and agree precisely with Henderson's description. It is also clear, from de Man's key, that they should be referred to this form; but the carpocerite¹ resembles that of *A. macrodactylus*, Ortmann, being equal in length with the antennular peduncle.

In the large chela of the specimens from the Chilka Lake the proportion of length to breadth is apparently variable; it is 3.6 times as long as broad in an adult female, 2.76 times in an adult male and 3.16 times in a younger male. In the third pair of legs the merus is nearly 7 times and the propodus about 10 times as long as broad.

On the whole the typical form seems to resemble the var. *leptopus* more nearly than the var. *dolichognathus*; but in the former variety, as shown in de Man's key,

¹ By the term carpocerite I understand the fifth segment of the antennal peduncle (see Calman in Lankester's *Treatise on Zoology, Crust.*, p. 265, text-fig. 156B, 1909) and I am unable to understand de Man's reference (*op. cit.*, p. 430, para. 2) from which one would gather that the carpocerite is composed of three segments.

the fingers of the small chela gape¹ and in the detailed description it is stated that their inner margins are unarmed. In typical *malabaricus* the fingers are parallel and meet throughout their length when the claw is closed (there is a slight gape in one specimen) and at the base of the dactylus, as described by Henderson, there is a large tooth.

In young specimens the spine which terminates the outer margin of the antennal scale frequently reaches forwards beyond the apex of the lamella as in var. *dolichognathus*; in large individuals, as in var. *leptopus*, it does not exceed this point.

It may hereafter be found that the two varieties cannot be maintained, though, in the present state of our knowledge, the three forms may be distinguished by the parallel or gaping fingers of the small chela, by the presence or absence of a proximal tooth on inner margin of the dactylus and by the relative proportions of the segments of the last three pairs of legs.

The largest specimen in the collection has a length of 29 mm. In this example the length of the large chela is 17 mm.

The colour of living specimens is very striking. The entire animal is semi-transparent with chromatophores of bright red or reddish-brown pigment arranged in transverse bars on the carapace and abdomen. The gastric and hepatic organs show through the carapace as blackish and greenish masses. Each of the transverse bars of chromatophores is broadest in the middle, narrowed and directed forwards on either side. On the carapace are four such bars, the posterior much the broadest, while on the abdomen there are seven, the last extremely narrow. There are also red chromatophores at the base of the telson and in the centre of the uropods, while the tips of these segments and of the telson are heavily blotched with deep blue. The antennules and antennae are almost colourless. The chelae of the first legs are dull sage green, dotted with reddish-brown, the tips of the fingers in the larger claw being fawn-coloured or pink. The second legs are transparent, dotted with red distally, and the last three pairs are transparent with the mero-carpal and carpo-propodal joints bright yellow. The eggs borne by ovigerous females are dull yellow.

Alpheus malabaricus is not uncommon in the outer channel of the Chilka Lake, but has not been found in the main area. It was taken off Satpara and in the vicinity of Barhampur I. at depths varying from 6 to 12 ft. living on a bottom of soft mud. Its habits are thus strikingly different from those of *A. crassimanus*, which occurs only on rough ground,—on oyster-beds or under stones. The species was found both in March, when the water was as salt as that of the Bay of Bengal near the lake-mouth, and in September when it was quite fresh. The only ovigerous female in the collection was obtained in March.

Dr. Annandale found examples of this species, also on muddy ground, in the Ennur backwater near Madras in January 1915. The species occurred in water of specific gravity 1.002 and one individual was bearing eggs.

¹ The reference to this point in the full description of var. *leptopus* is obscure, for the fingers are described as having "their inner margins shutting together."

The original specimens examined by Fabricius were from the "Indian Ocean"; Henderson's material was obtained at Pulicat, a locality not far distant from Ennur. Ortmann's var. *dolichognathus* is recorded from the Bay of Tokyo and de Man's var. *leptopus* from the East Indian Archipelago, S. of Celebes. One specimen of the var. *leptopus* was found at the unusual depth of 289 metres.

***Alpheus paludicola*, sp. nov.**

(Plate XIII, figs. 11-13.)

A species belonging to the *edwardsi* group, allied to *A. euphrosyne*, de Man, and *A. microrhynchus*, de Man.

The rostrum is exceedingly small, less conspicuous even than in *A. microrhynchus*, and consists of a minute triangular plate which reaches but little beyond the level of the extremities of the orbital hoods. Behind it the inter-orbital region is flattened and the post-rostral keel is quite obsolete, existing merely as an extremely feeble elevation, which can only be seen in dried specimens and disappears altogether before reaching the middle of the inter-corneal area. There are no perceptible inter-orbital grooves on either side of the middle line. The orbital hoods are well in advance of the anterior margin of the carapace on either side; their frontal edges are not strongly convex (pl. xiii, fig. 11). The carapace, except for a few microscopic punctuations, is smooth.

The lateral process of the basal antennular segment is broadly oval and terminates in a small spine which does not reach the end of the segment. The second segment is about equal in length with the first and about two and a half times as long as broad; the third segment is much shorter. The thickened portion of the outer flagellum is a little longer than the peduncle.

There is no anterior spine on the lower margin of the basicerite of the antenna. The carpocerite is slender and reaches beyond the antennular peduncle by a distance nearly equal to that of the last segment of the latter. The antennal scale (text-fig. 33a) is not so broad as in *A. euphrosyne*; the length is about 2.4 times the width. The spine which terminates the slightly concave outer margin reaches very little, if at all, beyond the apex of the lamella.

The ultimate segment of the outer maxillipede is fully one and three quarters the length of the penultimate; both these segments are much more slender than the antepenultimate.

In the large chelipedes the merus in large males may be only twice as long as broad; in a younger male 2.4 times and in an adult female 2.7 times. The upper edge is rounded and the spine found in *A. edwardsi* and *A. crassimanus* at the distal end of the infero-internal margin is absent. The carpus is very short, rounded above.

The large chela (pl. xiii, figs. 12, 13) is from 2.4 to 2.5 times as long as broad, the palm being about 1.5 times as long as broad. The rounded upper edge of the palm terminates obtusely in front of a well-defined transverse groove situated near the base of the dactylus; the lower edge ends more abruptly in a rounded prominence

at the base of the immobile finger. Near the upper edge of the palm, as in *A. crassimanus* and allied species, are two depressions, one on the inner surface and one on the outer: that on the inner surface is triangular in shape and that on the outer more or less quadrangular. These depressions are united by the transverse groove at the base of the dactylus. The inner surface of the palm, as in *A. crassimanus*, bears in its lower half a sharp transverse ridge near the base of the immobile finger; this ridge runs towards the prominence terminating the lower margin, but is separated from it by a longitudinal, infero-internal groove which extends backwards for almost the entire length of the palm. There is also another ridge, transverse in direction, which crosses the middle of the inner surface of the palm; it is bounded proximally by a curved groove which runs to the carpal articulation and between it and the more anterior transverse groove at the base of the immobile finger is a large shallow depression. These ridges and grooves on the inner surface of the palm appear to be characteristic of the species. Characteristic also is a very fine granulation on the inner side of the immobile and fixed fingers; the surface of the former is evenly rounded, but bears a short though conspicuous carina near the finger-tip. The outer surface of the chela more nearly resembles that of *A. crassimanus*; there is a broad shallow groove on the fixed finger and a feeble depression proximal to the transverse ridge which terminates on the marginal prominence at the end of the lower edge of the palm. In external view the inner margin of the fixed finger is prominently angled just in advance of the socket for the great tooth of the dactylus; near the apex the inner margin of the movable finger is decidedly sinuous. The fingers open somewhat obliquely, that is to say, in a plane different from that of the outer surface of the palm. The large chela of the female is proportionately a trifle broader than in the male, but has a closely similar structure.

As in most species of the *edwardsi* group the dactylus of the small chela is, in the male, subspatulate in form, "Balaeniceps-shaped," whereas in the female it is slender. In the male (text-fig. 33*b*) the small chela is nearly five times as long as broad and the fingers are about equal in length with the palm. On the upper edge of the latter there is a transverse groove behind the insertion of the dactylus and in lateral view the margin is consequently notched; there is a similar notch, rather less conspicuous, on the lower edge near the base of the fixed finger. On either side of the upper edge is a triangular depression reaching backwards to the middle of the palm and on the infero-internal aspect another longitudinal groove which extends almost the whole length. The palm is quite smooth, without the granulations found in *A. euphrosyne*. The greatest breadth of the dactylus is about one-third its total length. On its upper surface at the proximal end are two low crests, short, distally convergent and bearing a few setae. A sharp keel runs the whole length of the inner margin. Both fingers are strongly curved at the tips.

The small chela of the female is rather less than five times as long as broad and the fingers are a little longer than the palm. In both sexes the chela bears scattered setae, more numerous in the female than in the male.

In the second peraeopods (text-fig. 33*c*) the ischium is a little longer than the

merus, the latter segment being six and a half times as long as wide. The carpus is nearly one and a half times as long as the merus. Of the five segments of which it is composed, the first is about twice as long as the second; the fifth is nearly three quarters the length of the second and is nearly as long as the third and fourth combined, the two latter being sub-equal. The chela is a little longer than the second carpal segment; the palm is less than one and a half times as long as broad and is two-thirds the length of the fingers.

The merus of the third peraeopods is unarmed and is a little more than five times as long as broad. The propodus is slightly tapering, nine times as long as broad at the base; it bears long setae but no spines and is two and three quarter

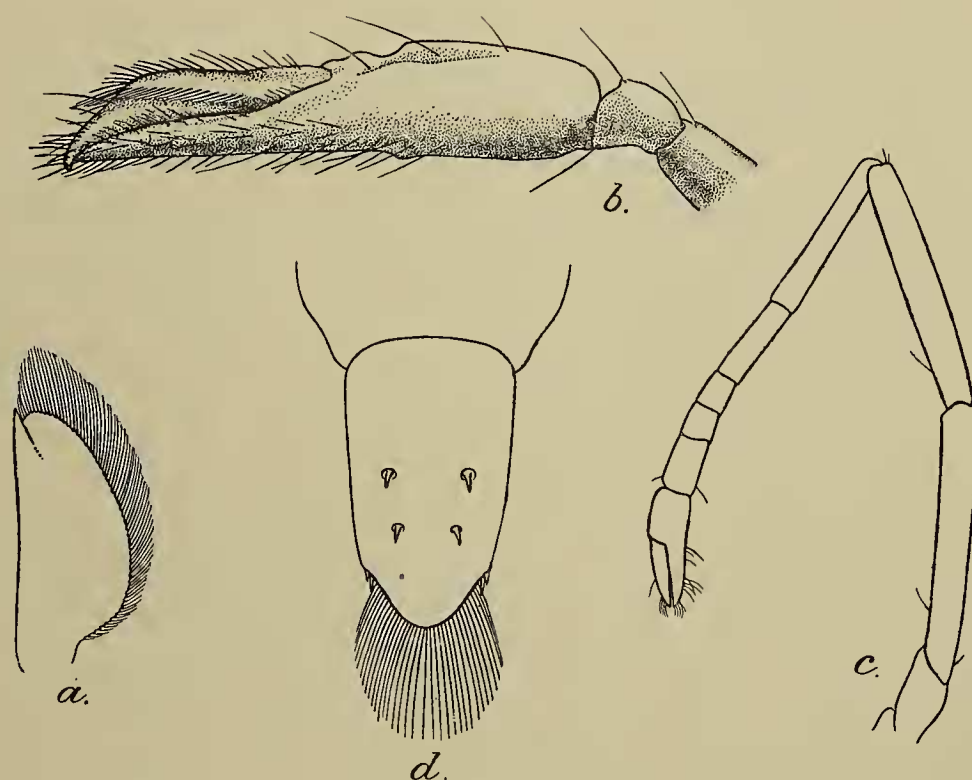


FIG. 33.—*Alpheus paludicola*, sp. nov.

a. Antennal scale.

b. Small chela of male.

c. Second peraeopod.

d. Telson.

times as long as the dactylus. The latter segment is spatulate as in *A. crassimanus* and is externally ridged. The remaining two pairs of legs are similar in form.

The telson (text-fig. 33d) reaches about as far as the uropods. The setose apex is rounded, but is produced far beyond the lateral spines. The breadth at the level of these spines is almost or quite two-thirds the basal breadth and is from one half to two-fifths the total length. The usual two pairs of dorso-lateral spinules are present, the proximal pair situated about in the middle of the telson. Both uropods are very broad; the exopod is nearly circular, little more than one and a quarter times as long as broad.

Large specimens of this species reach a length of about 22 mm. The eggs borne by females are very large, about 1.4 mm. in diameter.

Alpheus paludicola is allied to *A. euphrosyne*¹, de Man, and *A. microrhynchus*, de Man, and would find a place alongside these forms in the key which is supplied in the Report on the 'Siboga' Alpheidae. It agrees with these species and differs from *A. edwardsi*, Aud., *A. crassimanus*, Heller, and other closely related forms in the absence of a spine at the distal end of the infero-internal margin of the merus of the first peraeopods. It resembles *A. euphrosyne* in having both margins of the palm of the small chelipede of the male notched and *A. microrhynchus* in the diminutive size of the rostrum and large size of the eggs.

From *A. euphrosyne* the Chilka species may be distinguished by the much smaller rostrum, the narrower antennal scale, the more slender form of the small chela of the male (in *A. euphrosyne* it is only four times as long as broad), the different proportions of the segments in the carpus of the second peraeopods and the larger eggs. The large chela of *A. euphrosyne* has not been figured, but is apparently somewhat similar to that of *A. paludicola*. De Man describes granulations at the base of the fixed finger similar to those found in the Chilka species; but he also notes the existence of granulations on certain parts of the outer surface, and of these in *A. paludicola* there is no trace. In *A. euphrosyne*, moreover, the large chela is more slender, about three times as long as broad.

In *A. microrhynchus* the rostrum, though small, is decidedly larger than in the species from the Chilka Lake, there are no granulations on the large chela, the upper and lower margins of the small chela of the male are not notched behind the fingers and the proportional lengths of the carpal segments in the second legs are different.

Specimens were semitransparent in life, the black gastric mass and the intestinal canal being clearly visible through the carapace. The rostrum was brownish-red and the antennular peduncles and outer margins of the antennal scales were tinged with the same colour. At the hinder end of the carapace and of each of the abdominal somites was a transverse band of brown pigment, sometimes tending to a bluish-green shade laterally. The telson and uropods were as a rule dusky, often with a faint speckling of red and not infrequently suffused with light blue. The inner surface of the larger chela was reticulated proximally with dull brown. The base of the fingers and the ridges on the palm were greenish or greenish-blue, the tips of the fingers pink. The outer surface was pale. The small claw was feebly pigmented and the other legs entirely transparent.

Two individuals lived for about three months in a shallow dish, fresh water being added occasionally to compensate for evaporation. They constructed only the most rudimentary burrows, using the last three pairs of legs in excavation and their pleopods in wafting away the mud. Whenever possible the burrows were dug underneath shells or pieces of weed; they were entirely horizontal and never much longer than the animal. The large chela was used as a lever in removing obstructions.

Alpheus paludicola is common in the Chilka Lake; specimens were found at no less than twenty-one different stations. It was found over an area extending from

¹ For references to these species see de Man, *Decap. 'Siboga' Exped.*, II, *Alpheidae*, p. 413.

Rambha to Nalbano and also occurred off Barnikuda, in Seruanaddi, near Satpara and in the vicinity of Barhampur I. It was invariably obtained on a bottom of soft mud in water from 4 to 12 ft. in depth. Unlike *A. crassimanus*, it was never seen under stones at the margin of the lake. Specimens were found at all times of the year and the species is evidently able to tolerate changes in specific gravity varying from 1.000 to 1.0265. Ovigerous females were found in November and March. In the former of these months they occurred in water of very slight salinity, whereas in the latter months they were obtained in water as salt as that of the sea in the neighbourhood of the lake-mouth.

The type specimens bear the nos. 9020-2/10 in the Museum register.

Family ATYIDAE.

Genus CARIDINA, Milne-Edwards.

1905. *Caridina*, Bouvier, *Bull. sci. France Belgique*, XXXIX, p. 67.

1913. *Caridina*, Bouvier, *Trans. Linn. Soc., Zool.* (2), XV, p. 447.

Two species of this genus are commonly found in the Chilka Lake among weeds. Both occur abundantly in the Gangetic delta in brackish water.

Caridina nilotica (Roux).

var. *bengalensis*, de Man.

1908. *Caridina nilotica*, var. *bengalensis*, de Man, *Rec. Ind. Mus.*, II, p. 265, pl. xx, figs. 6, 6a, 6b.

For the form of *Caridina nilotica* which occurs in the Chilka Lake I have employed the varietal name given by de Man to the race found in the Gangetic delta.

There are numerous series of *Caridina nilotica* in the Indian Museum obtained at various points on the coasts of the Indian peninsula. Where precise data are available, it appears that these specimens were, with very few exceptions, obtained in brackish water or in water that, though fresh at the time of their capture, is occasionally subject to tidal influence.

These series of individuals all agree in possessing the characters of the var. *bengalensis* except that they show considerable variation in the dentition of the rostrum. Even in examples from the Gangetic delta the range of variation is much greater than is apparent from de Man's account, the teeth forming the basal crest on the upper margin varying in number from 15 to 30 and those on the lower margin from 11 to 22. On examining long series from different places it is evident that local distinctions exist in the number of rostral teeth; but these distinctions are so slight that it is only by taking the average of a large number of individuals that they can be detected and they are, of course, far too trivial to justify nominal recognition.

It is, however, interesting to note that the Chilka Lake examples agree more nearly with those from S. India than with those from the Gangetic delta, a fact which is shown in the following table:—

	Calcutta (Garia).	Chilka Lake.	Madras (Villy- vakkam).	Tuticorin.	Colombo.
No. of specimens examined	149	100	200	34	91
Dorsal teeth of rostrum, basal crest only ..	15—30	14—25	14—27	15—23	13—23
Ventral teeth of rostrum	11—22	6—19	9—20	11—19	8—18
Average no. of dorsal teeth	22·7	19·1	19·7	19·0	16·8
Average no. of ventral teeth	14·7	12·0	13·6	15·6	13·2
Length of eggs (mm.)	·41—·48	·42—·48	·42—·49	·47—·475	·43

In his work on the varieties of *C. nilotica*, de Man notes that var. *bengalensis* is very closely related to var. *gracilipes*, de Man, a form found in Celebes and Saleyer. From this race the Indian form is separated by the greater number of teeth on the upper edge of the rostrum and by the larger size of the eggs; but it seems probable that a distinction based on these grounds is untenable. The number of dorsal teeth in Indian specimens ranges from 13 to 30 and in var. *gracilipes* from 12 to 20. In the former the average number varies from 16·8 in the case of Ceylon specimens to 22·7 in the case of individuals from the vicinity of Calcutta, while in the latter, according to the results of de Man's examination of twenty-five specimens¹, the average number is about 15·8. The eggs vary in length from ·33 to ·40 mm. in var. *gracilipes* and from ·41 to ·49 in var. *bengalensis*.

Should it prove that no other distinctions are available, the name *gracilipes* must be used for the Indian form.

In the Chilka Lake *Caridina nilotica* was found only in Rambha Bay and in the outer channel; but in both these localities it was abundant. In Rambha Bay it was plentiful among weed near the margin of the lake and was also found near the rocks at the foot of Ganta Sila. Ovigerous females were taken both in February in water of sp. gr. 1·011 and in September in water of sp. gr. 1·006.

In the outer channel it was obtained in February at Satpara and near Mahosa in water as salt as that of the Bay of Bengal near the lake (sp. gr. 1·0265), but no females bearing eggs were to be found. In September when the water was fresh and stood at a level some 5 ft. higher than in February, the species was common in the same localities, living among the roots of screw-pines, and was also found in submerged grass on islands near Manikpatna. At this time of the year numerous egg-laden females were obtained. Our observations seem to indicate that very saline water inhibits reproduction.

The absence of *C. nilotica* from the vicinity of Barkul and from other places in the main area where weed is plentiful and the conditions apparently favourable is perhaps to be explained by the enormous abundance of *C. propinqua* in these localities. This prolific species has perhaps ousted *C. nilotica* from situations in which it would otherwise have occurred.

¹ de Man, in *Weber's Zool. Ergebn. Niederländ. Ost-Ind.*, II, p. 394 (1892).

Caridina nilotica, *sensu lato*, is known from an area extending from N. and S. Africa to Celebes.

***Caridina propinqua*, de Man.**

1908. *Caridina propinqua*, de Man, *Rec. Ind. Mus.*, II, p. 227, pl. xix, figs. 6, 6a—f.

1913. *Caridina propinqua*, Bouvier, *Trans. Linn. Soc., Zool.* (2), XV, p. 463.

The specimens of this species from the Chilka Lake agree closely with de Man's description and with individuals from the Gangetic delta.

According to de Man the species is allied to *Caridina fossarum*, Heller, and *C. laevis*, Heller; but these two forms are widely separated from *C. propinqua* in the valuable key to certain species of the genus which Bouvier has recently supplied. *C. propinqua*, in Bouvier's table, is distinguished from *C. laevis*, *C. fossarum* and numerous other species by the comparatively greater length of the antennular peduncle. This character is not easily determined with accuracy; but comparison between *C. laevis* (of which Javanese specimens are available) and *C. propinqua* indicates that in these two forms it affords a valid distinction.

As regards the rostral dentition, in 50 specimens from the Chilka Lake there are from 10 to 17 dorsal teeth (average 13.6) and of these from 2 to 5 (usually 3) are placed behind the orbit. On the ventral margin there are from 0 to 3 teeth (average 1.5). In examples from the Gangetic delta the teeth are as a rule rather more numerous. In 50 individuals from Durgapur the dorsal teeth vary in number from 9 to 22 (average 16.7) with from 2 to 5 (usually 4) situated on the carapace behind the orbit. On the ventral margin there are from 0 to 4 teeth (average 1.8).

There is also a slight difference between specimens from the two localities in the form of the first pair of peraeopods, these limbs being a trifle more slender in the Gangetic form than in that found in the Chilka Lake. The distinction is, however, too trifling to be expressed by means of measurements.

In both forms the propodus of the last leg is about 2.4 times the length of the dactylus and no differences are to be found in the number of dactylar and uropodial spines and other characters enumerated by de Man.

The eggs are of the same size as in individuals from the Gangetic delta; they vary from 0.51 mm. in length and 0.32 mm. in breadth when first extruded, to 0.6 mm. in length and 0.38 mm. in breadth, when on the point of hatching.

Caridina propinqua occurs in all parts of the main area of the Chilka Lake throughout the year and is especially abundant in thickets of *Potamogeton* off Cheria I., in Barkul Bay and near Nalbano. In the outer channel it was obtained only in the freshwater season (September) and then in no great abundance, specimens being found in Seruanaddi and, in company with *C. nilotica*, among roots of screw-pines near Arupatna and in submerged grass on the islands near Manikpatna.

In the main area the species appears to breed throughout the year; ovigerous females were obtained in the months of January, February, March, July, September and November. A few egg-laden females were also found in September in the outer channel.

From the records available it seems that *C. propinqua* is found only at the northern end of the Bay of Bengal. In addition to samples from the Chilka Lake and the Gangetic delta we have specimens from Chittagong, from Cuttack and, in the vicinity of Puri, from Athara nullah and the Sar Lake. The individuals from the last named locality and from Cuttack were obtained in water that remains permanently fresh; but the species is more usually found in places subject to tidal influence.

Family PASIPHAEIDAE.

Genus **LEPTOCHELA**, Stimpson.

1860. *Leptochela*, Stimpson, *Proc. Acad. Sci. Philadelphia*, XII, p. 42.

1896. *Leptochela*, Caullery, *Ann. Univ. Lyon*, XXVI, p. 372.

The species of this genus found in the Chilka Lake is also common in suitable localities on other parts of the Indian Coast and, as in *L. carinata*, Ortmann, from the Atlantic coast of America shows marked sexual distinctions. In the female the carapace bears a distinct median carina with an additional carina of considerable length on either side of it, whereas in the male the median carina is less distinct and the lateral carinae are wanting. This sexual distinction may be proper to several other species of the genus, a fact which should be borne in mind when the character is used for the discrimination of allied forms.

The following five species of *Leptochela* have been described; the first two from the Atlantic coast of America, the remainder from the Indo-pacific:—

1. *Leptochela carinata*, Ortmann¹: distinguished by the presence of four teeth on the mid-dorsal carina of the fifth abdominal somite.

2. *Leptochela serratorbita*, Bate²: distinguished by the finely serrated or spinulose orbital margin.

3. *Leptochela gracilis*, Stimpson³, the type species of the genus: distinguished by the presence of a sharp tooth at the distal end of the carina on the fifth abdominal somite. A fresh account of this species is badly needed. It is not certain that the specimens recorded under this name by Bate⁴ are correctly identified.

4. *Leptochela robusta*, Stimpson, cannot be recognised with any certainty from the original description.⁵ Bate's⁶ subsequent account and figures are probably unreliable, but de Man's detailed description of a single male from Ternate⁷ will afford a useful basis for future work. I am not convinced that the Hawaiian specimens

¹ Ortmann, *Decap. Schizop. Plankton-Exped.*, p. 41, pl. iv, fig. 1 (1893) and Rathbun, *Bull. U.S. Fish Comm. for 1900*, XX, 2, p. 127 (1902).

² Bate, *Rep. 'Challenger' Macrura*, p. 859, pl. cxxxix, fig. 1 (1888) and Rathbun, *Bull. U.S. Fish Comm. for 1900*, XX, 2, p. 127 (1902).

³ Stimpson, *loc. cit. supra*, p. 42.

⁴ Bate, *Rep. 'Challenger' Macrura*, p. 860, pl. cxxxix, fig. 2 (1888).

⁵ Stimpson, *loc. cit. supra*, p. 43 (1860).

⁶ Bate, *Rep. 'Challenger' Macrura*, p. 862, pl. cxxxix, figs. 3, 4 (1888).

⁷ de Man, *Abhandl. Senckenb. naturf. Ges. Frankfurt*, XXV, p. 902.

recorded by Miss Rathbun¹ are specifically identical with that described by de Man. The species, which should bear the name of *L. robusta*, Stimpson (de Man), is apparently characterized by the absence of the special features that distinguish *L. carinata*, *L. serratorbita* and *L. gracilis* and by the presence of three pairs of spinules on the dorsal surface of the telson in addition to those at the apex.

5. *Leptochela aculeocaudata*, Paulson², is probably a close ally of *L. robusta*, from which it is distinguished by the presence of only two pairs of spinules on the dorsal surface of the telson in addition to those at the apex.

Leptochela reversa, Bate³, is apparently a *nomen nudum*.

The Indian form is provisionally identified with *L. aculeocaudata*, a determination which premises a considerable amount of error in Paulson's figures and that the marked sexual differences in the carination of the carapace escaped his notice.

Caullery (*loc. cit. supra*) in his account of the Decapoda collected by the 'Caudan' expedition has provided a valuable key to the five more well-established genera of Pasiphaeidae. *Leptochela* is distinguished from other genera by the possession of a mandibular palp composed of a single segment and by the presence of laciniae on the inner margin of the second maxilla.

The branchial formula in the Indian species is apparently identical with that found in *Parapasiphaë*, Smith:—

	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchiae ..	ep.	ep.	ep.	..	..	..	..	..
Arthrobranchiae ..	..	..	2	I	I	I	I	..
Pleurobranchiae ..	..	..	..	I	I	I	I	I

Leptochela aculeocaudata, Paulson.

(Plate XIII, fig. 14.)

1875. *Leptochela aculeocaudata*, Paulson, *Crust. Red Sea*, p. 100, pl. xvi, fig. 1.

1906. *Leptochela aculeocaudata*, Nobili, *Ann. Sci. nat. Paris*, (9), IV, p. 28, text-figs. 4a-c.

In dorsal view the rostrum is broad at the base, but narrows rapidly to a sharp apex. It is very short; in the male it reaches only to the middle of the cornea, while in the female it is rather longer and may reach to the end of the eyes; it is occasionally a little upturned at the apex. The rostrum bears a longitudinal dorsal carina which extends backwards on the carapace. In the male this carina is not sharp and disappears altogether before reaching the middle of the carapace. In the female (pl. xiii, fig. 14) it is much more conspicuous and is continued to the middle of the posterior quarter of the carapace as a thin compressed keel. In this sex there

¹ Rathbun, *Bull. U. S. Fish Comm. for 1903*, XXIII, p. 929 (1906).

² Paulson, *Crust. Red Sea*, p. 100, pl. xvi, fig. 1 (1875) and Nobili, *Ann. Sci. nat., Zool.* (9), IV, p. 28, text-figs. 4, a-c (1906).

³ Bate, *Rep. 'Challenger' Macrura*, p. 722 (1888).

is also a smoothly rounded ridge on either side of the median carina, running parallel with it and commencing near the upper part of the orbital margin. In the male these ridges are non-existent. The carapace is strongly compressed and, as in other species of the genus, the posterior margin is deeply excavate mid-dorsally. The orbital and antero-lateral angles are bluntly rounded.

The eyes are short and globular, the breadth of the cornea being much greater than that of the stalk. The antennular peduncle (text-fig. 34a) reaches a little beyond the middle of the antennal scale. In lateral view the basal process is lanceolate in shape; its margins bear long setae and the apex reaches to the distal end of the segment to which it is attached. The third segment is longer than the second. The two antennular rami are stouter in the male than in the female. The outer ramus is

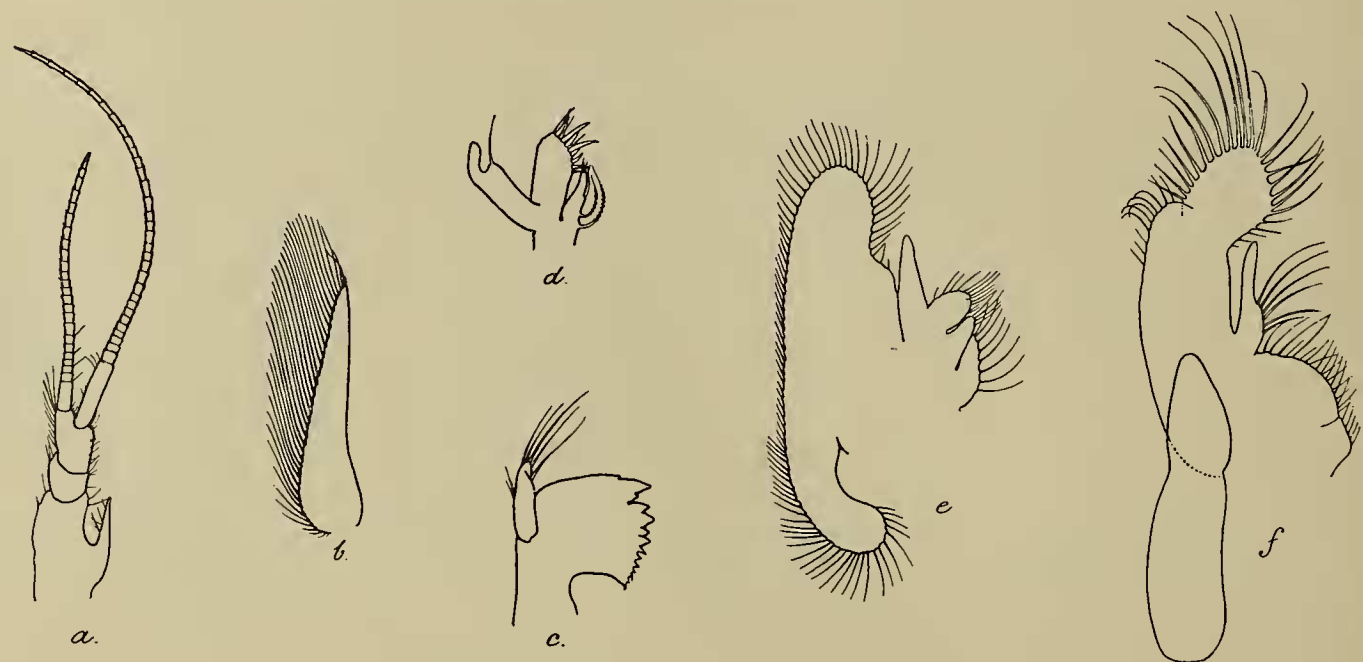


FIG. 34.—*Leptochela aculeocaudata*, Paulson.

a. Antennule of female.
b. Antennal scale.
c. Mandible.

d. First maxilla.
e. Second maxilla.
f. First maxillipede.

the longer; when flexed backwards it reaches to the end of the carapace in the female and about to the middle of the third abdominal somite in the male.

The antennal scale (text-fig. 34b) is narrowly triangular, about four times as long as broad, the lamella at the distal end sloping rapidly away from the base of the terminal spine. The outer margin is sinuous in both sexes, concave behind the middle point and slightly convex onwards to the apex.

The cutting edge of the mandible (text-fig. 34c) in its outline resembles Paulson's figure, but bears from 12 to 15 teeth. It is not cleft in the middle as, according to Stimpson's account, it is in *P. gracilis*. The palp is composed of a single segment, somewhat expanded laterally and furnished with setae on its margins. Three laciniae are well developed on the inner edge of the second maxilla (text-fig. 34e).

The first maxillipede (text-fig. 34f) bears a large bilobed epipod (not shown in

Paulson's figure) and a curious rounded lobe on the external margin of the exopod near its apex. On the second maxillipede¹ (text-fig. 35a) there is a small epipod, but no exopod. The last two segments of the endopod bear conspicuous spines; the ultimate segment is acutely produced at the apex.

The third maxillipedes (text-fig. 35b) reach about to the end of the antennular peduncle and bear both epipod and exopod, the latter reaching the distal end of the antepenultimate segment. The ultimate segment bears a few stout setae at its apex and is a little shorter than the penultimate.

The first and second peraeopods (text-figs. 35c, d) reach about to the end of the antennal scale, the latter pair being slightly longer than the former. The exopod of the first pair reaches nearly to the end of the ischium; that of the second pair is a trifle shorter. The ischium is longer than the merus and decidedly shorter than the chela. The palm is about one and a half times the length of the carpus and the fingers are almost or quite one and a half times the length of the palm. On the inner edges of the fingers are numerous forwardly directed spinules, three or four of which are noticeably longer than the others. The spinulation on the lower edges of the segments varies according to sex; but in both male and female there are two or three large spinules on the basis. In the female there are a number of large spinules on the inferior margins of the merus, carpus, palm and dactylus; in one specimen in which they appear to be specially well developed there are 6 on the merus, 4 on the carpus, 5 on the palm and 6 on the dactylus. In the male the spinules are smaller and appear to be less numerous. There is always a strong spinule at the upper distal end of the ischium.

The third peraeopods (text-fig. 35e) reach to the carpus of the second pair; the exopod extends a little beyond the middle of the ischium. The ischium is the longest segment, its length exceeding that of the two following combined. The propodus is one half the length of the merus, nearly twice the length of the carpus and fully one and a quarter times as long as the dactylus. On the upper edge there are long setae at the distal end of the ischium and on the merus; on the lower edge there are numerous setae on all the segments and 3 spinules on the ischium, 4 on the merus and 1 on the carpus.

The fourth and fifth peraeopods are much reduced and do not reach the anterior margin of the carapace. The fourth legs (text-fig. 35f) are remarkable for the large ventral spine borne by the ischium. This spine slopes strongly forwards and, just in advance of its base on the protruding margin of the segment, are two small movable spinules (text-fig. 35g). The apparatus is perhaps used for cleaning the appendages, acting as a comb. The exopod reaches a little beyond the end of the ischium. The merus and carpus are subequal in length, a little longer than the ischium. The dactylus is five sevenths the length of the carpus and one sixth longer than the propodus,

¹ Paulson's figure of this appendage seems to be wholly erroneous. Owing to faulty dissection he has in one of his preparations confounded the first and second maxillipedes, the exopods of the former appearing as a portion of the latter.

the latter segment being less than two and a half times as long as wide. There are stout setae on the ventral margins of all the segments except the ischium and, on the upper margin, on the carpus and at the distal ends of the ischium and merus.

In the fifth pair (text-fig. 35*h*) the exopod is short and broad, not reaching much beyond the middle of the ischium. The merus and carpus are subequal in length, about one and a half times the length of the propodus. The latter segment is a little shorter than the dactylus. On the ventral margins of the ischium and



FIG. 35.—*Leptochela aculeocaudata*, Paulson.

- | | |
|------------------------|--|
| a. Second maxillipede. | f. Fourth pereopod. |
| b. Third maxillipede. | g. Spines on lower margin of ischium of fourth pereopod, further enlarged. |
| c. First pereopod. | h. Fifth pereopod. |
| d. Second pereopod. | i. Telson with outer and inner uropods. |
| e. Third pereopod. | j. Apex of telson, further enlarged. |

merus there is, among others of more slender build, a single stout seta; otherwise the limb is clad in setae much as in the fourth pair.

The first four abdominal somites are smoothly rounded dorsally; the pleura of the first two are greatly enlarged in the female. The fifth somite is very obscurely carinate in the mid-dorsal line, but the carina is not produced posteriorly as a spine. The sixth somite is smoothly rounded above; at its anterior end there is a short transverse ridge on the dorsal surface which, in lateral view, has the appearance of a tubercle. On the posterior margin there is a pair of small spinules, one on either side, overhanging the articulation of the telson. The ventral margins are fringed with

setae, among which, in the posterior half of each, a sharp backwardly directed spine may be detected.

The telson (text-fig. 35*i*) reaches beyond the end of the uropods and is strongly sulcate above. Apart from those at the apex there are only two pairs of dorsal spines; the first pair is situated near the anterior margin of the telson; the second about in the middle of its length. At the apex are *five* pairs of spines, the respective lengths of which are shown in text-fig. 35*j*.¹ Except for the outermost, all these spines are internally pectinate, the innermost being also pectinate externally.

The outer uropod is a little more than three times as long as wide. The straight outer margin terminates in two spines in front of which are from 8 to 11 additional spines interspersed among fine setae. At the apex of the inner uropod on its dorsal side there are also three or four slender spines.

Large specimens attain a total length of about 16 mm.

Indian specimens differ in several points from Paulson's figures and from the translation of his description which Nobili has supplied. The individual drawn by Paulson in fig. 1 is apparently a female and, if I am right in assuming that the Indian examples belong to the same species, the lateral ridges on the carapace on either side of the middle line are incorrectly shown. These ridges should be parallel and should extend further backwards.

Leptochela robusta, Stimpson, judging from de Man's account of a single male², is apparently a very close ally of *L. aculeocaudata*; but, apart from less conspicuous details, differs from it in the armature of the telson. According to de Man's description there are in this species three pairs of spines on the upper surface of the telson, the posterior pair situated about in the middle of its length. In *L. robusta*, also, there are four pairs of spines at the apex of the telson in place of the five found in *L. aculeocaudata*.

In life specimens are transparent with the oral appendages, the bases of the thoracic limbs and pleopods, the hinder half of the last abdominal somite and telson bright red. The carapace, abdomen, antennae, antennules, uropods and the greater part of the thoracic and abdominal appendages are colourless. The eggs are opaque and whitish.

Of *Leptochela aculeocaudata* only a single individual was found in the Chilka Lake. It was obtained in the outer channel near Barhampur I. in March in water of specific gravity as high as that of the Bay of Bengal in the vicinity of the lake (1.0265). The species is clearly no more than a casual visitor to the lake.

There are numerous other examples of the species in the Indian Museum. In 1889 the R.I.M.S. 'Investigator' obtained a specimen 3 miles E.S.E. of Puri (a position not far distant from the mouth of the Chilka Lake) at a depth of 10 fms.

¹ The spines of the third pair are shorter than the second and fourth and are partially concealed by them.

² *loc. cit.*, *supra*, p. 310

More recently the 'Investigator' found the species in large numbers in the Mergui Archipelago (lat. $11^{\circ}58'20''$ to $12^{\circ}48'$ N.; long $98^{\circ}16'10''$ to $98^{\circ}26'30''$ E.) at depths varying from 8 to 24 fms. During the present year I found a number of specimens, mostly on a muddy bottom, at Port Blair in the Andamans in from 1 to 10 fms. and in 1913 obtained a few examples in shallow water among weeds at Kilakarai in the Ramnadi District at the northern end of the Gulf of Manaar.

The species has hitherto been recorded only from the Red Sea.

Tribe PENAEIDEA.

Family PENAEIDAE.

Five species belonging to this family occur in the Chilka Lake. Four of them are abundant and are caught in large numbers by the Uriya fishermen in special traps, which will be described in a subsequent paper in this volume. The trap depends for its efficacy on the habits of the prawns, which travel at night along the shore in very shallow water. If they meet with any obstruction they make their way along it and are thus, by means of training fences, easily led into an enclosure surrounded by traps, into the apertures of which they apparently force themselves on the approach of daylight. On Barnikuda I. there is a factory in which Penaeid prawns are dried for export, the greater part of the supply finding its ultimate destination in Burma.

The little knowledge we at present possess of the prawn fisheries in the Gangetic delta tends to show that there is an annual migration of Penaeidae to the sea. This migration takes place in the winter months and apparently coincides with the beginning of the breeding season.¹ In the Chilka Lake we found no clear evidence of migrations; three at least of the species are found throughout the year, but it is tolerably certain that none of them breed in the lake. The shallow waters of the main area with the dense beds of weed that exist in many parts would seem to afford an admirable nursery for young Penaeids. In such localities, however, we failed to find them: all the young specimens in our collection were obtained in the outer channel. It is only to adolescent prawns that the main area of the lake is attractive; early post-larval stages are seemingly unable to withstand the changes in salinity, while the fact that no very large specimens were obtained (though individuals with well-developed secondary sexual characters are not uncommon) tends to show that after they have returned to the sea for breeding purposes they do not again re-enter the lake.

Thanks to Alcock's memoir on the Indian prawns of the *Penaeus* group, the characters of most of the Indian species are now well known; but more recent work has unfortunately made necessary a number of changes in the nomenclature that he adopted.

¹ On the British coasts somewhat similar migrations are known in the case of *Pandalus montagui* [v. Kemp, *Fisheries, Ireland, Sci. Invest. for 1908*, p. 87 (1910)].

Genus **PENAEUS**, Fabricius (Smith).

1906. *Peneus*, Alcock, *Cat. Indian Decap. Crust.*, III, i, p. 4.

1911. *Penaeus*, de Man, *Decap. 'Siboga' Exped.*, I, *Penaeidae*, p. 95.

De Man's examination of the type specimen of *Penaeus semisulcatus*, de Haan, has had unfortunate consequences, for it involves an alteration in the names given by Alcock to two of the most abundant Indian species of the genus.

Alcock's *Penaeus semisulcatus*, the common salt-water prawn of the Calcutta markets, is shown to be specifically different from that described in the Fauna Japonica and is identified by de Man (though the determination is perhaps open to question) with Dana's *P. carinatus*. The form described by Alcock under the name of *P. monodon*, Fabricius, is however identical with de Haan's *semisulcatus*: the points of distinction which de Man notices (*loc. cit.*, p. 98) between de Haan's type and Alcock's figures have no real existence, a fact which I have been able to determine by an examination of Indian specimens and by comparison with Japanese examples received from Prof. Kishinouye under the name of *P. ashiaka*.

The description that Fabricius gave of his *Penaeus monodon* is insufficient for its recognition; but it was found in Indian seas and it is clear that the name must belong to one of the three forms which, in de Man's memoir, are referred to as *P. semisulcatus*, *P. carinatus* and *P. indicus*. De Man has not associated any species with the Fabrician name and it is probably best that it should be ignored, though the possibility that the type specimen still exists must remain a menace to the stability of the revised nomenclature.

Two species of *Penaeus*, *P. carinatus*, Dana (de Man) and *P. indicus*, M.-Edw., are common in the Chilka Lake. They are to be found at all seasons of the year both in the main area and in the outer channel and are able to exist in water varying in specific gravity from 1.000 to 1.0265.

Penaeus carinatus, Dana (de Man).

1906. *Peneus semisulcatus*, Alcock (not of de Haan), *Cat. Indian Decap. Crust.*, III, i, p. 10, pl. i, fig. 2.

1911. *Penaeus carinatus*, de Man, *Decap. 'Siboga' Exped.*, I, *Penaeidae*, p. 101.

The precise meaning of de Man's statement (*loc. cit.*, p. 102, end of para. 1) is not quite clear to me. As I understand it, he implies that, should the identity of Alcock's *monodon* and de Haan's *semisulcatus* be established, he would consider it justifiable to use the name *monodon* for the species which he himself records as *P. carinatus*, Dana. As stated above, I have been able to establish the identity he postulates; but, now that Alcock's application of *monodon* is shown to be incorrect, I do not think it can safely be used for any other species.

It is a choice of evils. As the matter rests at present, it seems to me better to employ the term *carinatus*, as a provisional measure, and one less liable to cause confusion than that consequent on a re-introduction of the name *monodon* in a new sense and without any certainty that its application would be well-founded. Even

de Man's identification of *P. carinatus* is, however, open to criticism, for Dana neither figures nor mentions the subhepatic crest of the carapace. It is most unfortunate that the correct name of this species, the common prawn of the Calcutta markets, must still remain uncertain.

Adults of the species are deeply pigmented with a tint varying from olive green to deep bluish-grey, usually the latter in large examples, with darker transverse bars on the abdomen. The colouring is sometimes almost as bright as in Stebbing's figure¹ of *P. caeruleus*; the bars have the same distribution, but are always more conspicuous in life. The outer surface of the protopodite of each pleopod is invariably bright lemon yellow, a distinctive feature not shown in Stebbing's figure and hardly indicated in that which Kishinouye has given of *P. monodon*² (a synonym of *P. carinatus*).

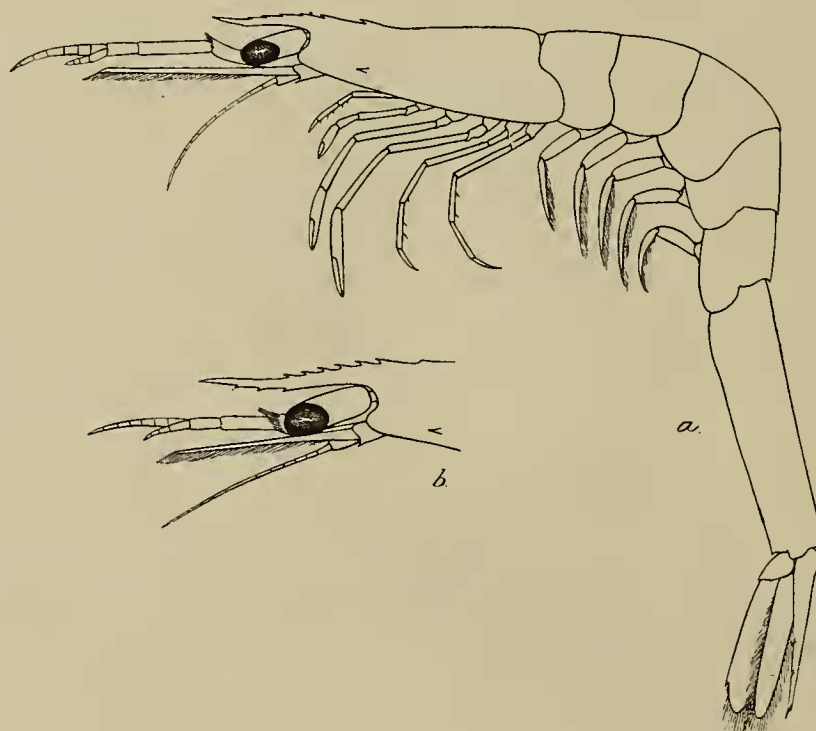


FIG. 36.—*Penaeus carinatus*, Dana (de Man).

a. Pelagic post-larval stage.

b. Rostrum, eyes, etc. of a somewhat older specimen.

In young specimens some 2 or 3 inches in length the colour is pale grey with a dark green mottling among which the transverse bars of the abdomen are only detected with difficulty. The yellow patches on the pleopods are absent.

¹ Stebbing, *Marine Invest. S. Africa*, IV, pl. xxi bis (1905). *P. caeruleus*, according to Stebbing, does not possess an exopod at the base of the last legs; but de Man has found this appendage in one of the type specimens and queries *P. caeruleus* as a synonym of de Haan's *semisulcatus*. I have never seen a fresh specimen of the latter and consequently have no knowledge of its colouration. Stebbing notes that the integument of *P. caeruleus* "has the property of retaining for years in preservative media (spirit and formalin) the fascinating blue colour to which the specific name refers." This is certainly not the case with *P. carinatus*: specimens turn red after only a day's immersion in alcohol.

² Kishinouye, *Journ. Fish. Bureau Tokyo*, VIII, pl. ii, fig. 1 (1900). The figure appears to have been coloured from a preserved specimen.

Still younger post-larval individuals, which I believe are correctly referred to this species, differ from those of all allied forms with which I am acquainted in their extremely slender build (text-figs. 36a, b). When very young, about 10 mm. in length, they are pelagic and are transparent with a crimson streak running along the ventral surface involving the whole of the antennules and the telson, but not the other appendages, except to a slight extent the uropods.¹ They possess two pairs of lateral spines on the telson and the rostrum, which in the youngest individuals is without inferior teeth, reaches a little beyond the eyes.

Rather larger post-larval specimens still retain their slender build, but are deeply mottled with dark grey and dull green and live among weeds. Both colour and form are doubtless protective, as in Hippolytids of the genus *Tozeuma*, to which these post-larval Penaeids bear a curious resemblance. When captured they are very conspicuous, for, apart from the attenuated form, their deep colouration readily distinguishes them from other species with which they are associated. These, as a rule, consist of other young Penaeidae, young Palaemonidae and *Caridina*, all of which are semitransparent and but little pigmented.

Penaeus carinatus is to some extent a migratory species. I am inclined to think that it ascends estuaries and makes its way into water of low salinity only at those seasons in which it is not breeding. It is practically absent from the Calcutta markets for several of the winter months, the supply for this market coming entirely from brackish water. The pelagic post-larval form, which was common in the Ennur backwater near Madras in January, was obtained in the Chilka Lake only in the outer channel in the salt-water season. The latter non-pelagic stage is not uncommon in the vicinity of Calcutta in early spring, but, strangely enough, is not represented in our collection from the Chilka Lake. The pelagic form is apparently carried by the tide well up into the Gangetic delta and settles down in weedy pools and backwaters many miles from the sea, to which the adults annually resort at the breeding season.

In the Chilka Lake *P. carinatus* was less abundant than some other species of Penaeidae; it was, however, found both in the main area and in the outer channel and occurred in both regions at all seasons of the year. It is certainly able to exist for considerable periods in water that is quite fresh.

The species has a recorded distribution ranging from Japan to Karachi.

***Penaeus indicus*, Milne-Edwards.**

1906. *Peneus indicus*, Alcock, *Cat. Indian Decap. Crust.*, p. 12, pl. i, figs. 3, 3a.

1911. *Penaeus indicus* var. *longirostris*, de Man, *Decap. 'Siboga' Exped.*, I, *Penaeidae*, p. 103 and (1913) pl. ix, figs. 32a, b.

The variety *longirostris*, described by de Man, is based entirely on the length of the rostrum and the great degree of variation that Indian specimens exhibit in this

¹ *P. gracilis*, Dana, *U. S. Explor. Exped.*, *Crust.*, I, p. 606, pl. xl, figs. 7a, a', b (1852) is apparently a related post-larval form.

respect leads me to believe that the varietal name cannot be retained. The largest examples from the Chilka Lake do not exceed 120 mm. in length and, in them, the rostrum exceeds the tip of the antennal scale by one-fourth or one-fifth of its length.

In life the general colour is translucent whitish, with numerous small brownish, greyish, or greenish chromatophores scattered over the carapace and abdomen. The upper half of the rostrum, base of the eyestalks, dorsal carinae of the last three abdominal somites, telson and uropods are deeply pigmented with maroon and dull brown chromatophores. The antennae and the terminal parts of the exopods of the second and third maxillipedes are pinkish; the tips of both uropods and the external margins of the outer pair are pinkish-red with similarly coloured setae. The antennular flagella are lemon yellow, banded and dotted with maroon.

In the Chilka Lake *P. indicus* is more abundant than *P. carinatus*. It is caught in large numbers by the Uriya fishermen and occurs at all seasons of the year both in the main area and in the outer channel. In the latter region a young form was taken in abundance which must, I believe, be referred to this species. In life it is semitransparent, sparsely pigmented with brown; the rostrum is very long, toothed both above and below. It does not present the attenuated appearance of late post-larval individuals of the preceding species. Unfortunately no specimens corresponding to the pelagic stage of the latter were obtained.

P. indicus appears to have a distribution extending from E. Africa and the Red Sea to China, but not reaching Japan.

Genus **PENAEOPSIS**, Bate.

1881. *Penaeopsis* (A. Milne-Edwards, MS.), Bate, *Ann. Mag. Nat. Hist.* (5), VIII, p. 182.

1891. *Metapenaeus*, Wood-Mason, *Ann. Mag. Nat. Hist.* (6), VIII, p. 271.

1906. *Metapeneus*, Alcock, *Cat. Indian Decap. Crust.*, III, i, p. 16.

1909. *Penaeopsis*, A. Milne-Edwards and Bouvier, *Mem. Mus. Comp. Zool. Harvard*, XXVII, p. 220.

1911. *Penaeopsis*, de Man, *Decap. 'Siboga' Exped.*, I, *Penaeidae*, p. 53.

Bate's description of this genus is worthless; but it is clear from the work of A. Milne-Edwards and Bouvier (1909) that *P. serratus*, the type species of the genus, is indistinguishable generically from the forms on which Wood-Mason based his *Metapenaeus*. The latter name must consequently lapse.

Three species of this genus occur in the Chilka Lake. Two of them, *P. monoceros* (Fabr.) and *P. dobsoni* (Miers) are abundant and are found throughout the year both in the main area and in the outer channel. The third, *P. affinis* (A. M.-Edw.), is apparently scarcer; though not found in the outer channel there can be little doubt that it occurs there, for specimens were obtained at all seasons in the main area and numerous examples were recorded by Alcock from the 'Investigator' dredgings on the Orissa coast. All three forms are evidently able to exist in water of specific gravity varying from 1.000 to 1.0265; but I think it improbable that any of them breed in the lake. Species of this genus were more frequently caught in our bottom nets in the middle of the main area than those of *Penaeus*.

***Penaeopsis monoceros* (Fabricius).**

1906. *Metapeneus monoceros*, Alcock, *Cat. Indian Decap. Crust.*, III, i, p. 18, pl. iii, figs. 7, 7a-c.

1911. *Penaeopsis monoceros*, de Man, *Decap. 'Siboga' Exped.*, I, *Penaeidae*, p. 55, and (1913) pl. vi, figs. 14a, c.

The small tooth at the distal extremity of the ischium of the first peraeopods, mentioned by de Man (*loc. cit.*, p. 56) is present in Indian examples of this species.

P. monoceros is very abundant in the Chilka Lake and is brought into the local markets in large numbers. It occurs both in the main area and in the outer channel at all seasons of the year.

In life specimens are semitransparent, closely covered with small red chromatophores. The dorsal carina of the carapace, the rostrum, the bases of the eyestalks, the dorsal abdominal carinae and the carinae of the telson and uropods are defined by dull red pigmentation. The antennae are bright red, the first two legs colourless, the last three with numerous red chromatophores. The setae that fringe the uropods are golden red and the outer uropod is bright red along its external margin. The nerve-cord is sheathed in red pigment and is clearly visible from beneath.

The species is known from an area extending from the Indus delta to Hongkong and Japan and perhaps also occurs in Australia.

***Penaeopsis affinis* (A. Milne-Edwards).**

1906. *Metapeneus affinis*, Alcock, *Cat. Indian Decap. Crust.*, III, i, p. 20.

1911. *Penaeopsis affinis*, de Man, *Decap. 'Siboga' Exped.*, I, *Penaeidae*, p. 57, and (1913) pl. vi, figs. 15a, b.

At the time of their capture specimens of this species were not distinguished from *P. monoceros*. In the collection are some twenty individuals, the largest, about 105 mm. in length, obtained in February and March at various localities in the main area between Rambha and Kalidai I. *P. affinis* is recorded by Alcock from 'Investigator' dredgings on the Orissa Coast; it therefore doubtless occurs in the outer channel and it is probable that, like *P. monoceros* and *P. dobsoni*, it is to be found in the lake at all seasons of the year.

The species is known to be distributed over an area extending from the Indus delta to Japan.

***Penaeopsis dobsoni* (Miers).**

1906. *Metapeneus dobsoni*, Alcock, *Cat. Indian Decap. Crust.*, III, i, p. 21, pl. iii, figs. 9, 9a-d.

1911. *Penaeopsis* sp., de Man, *Decap. 'Siboga' Exped.*, I, *Penaeidae*, p. 60 and (1913) pl. vi, fig. 17.

With respect to this species Alcock notes that in the vast majority of the females that he examined the fifth legs are reduced to a pair of horn-capped stumps. *P. dobsoni* is very abundant in the Chilka Lake, but in every female obtained the last legs are of normal length. It appears to me highly probable, as has already been suggested by Nobili, that the degeneration of these limbs is in some way connected with reproduction and, if this should prove to be the case, the condition of the Chilka

specimens lends support to the view, based on other evidence, that this species at any rate does not breed in the lake.

In the larger males the great barbed spine at the base of the third legs is well developed.

It is only in very large individuals that the rostrum has the comparatively straight dorsal outline shown in Alcock's figure. In the Chilka specimens, which do not exceed 75 mm. in length, there is a well elevated basal crest reaching from the posterior spine of the dorsal series to a point opposite the extremity of the eyes.

There can, I think, be no doubt that the specimen from Makassar recorded by de Man as '*Penaeopsis* sp.' is to be referred to this species. The figure of the thelycum is an exact representation of that of *P. dobsoni*; it is indeed more exact than the figure in Alcock's memoir, the latter suggesting a slight asymmetry which has no actual existence.

In life *P. dobsoni* is semitransparent; the pigment spots scattered on the carapace and abdomen are for the most part red, but tend to a browner shade on the rostrum and to a greenish tone on the posterior edges of each of the abdominal pleura. The antennules, antennae and antennal scales are dotted with red. There is a double row of reddish spots on the telson, the margins being greenish. Both uropods are red at the tip, the exopod being also bordered with red externally.

Like *P. monoceros*, this species is abundant in all parts of the Chilka Lake at all seasons of the year. It is particularly common in the main area on a muddy bottom. It appears to have a more restricted distribution than other species and has been recorded from both sides of the Indian Peninsula and from Makassar.

Family SERGESTIDAE.

Subfamily LUCIFERINAE.

Genus LUCIFER, Vaughan Thompson.

In giving an account of certain pelagic Decapoda collected by Mr. J. Stanley Gardiner¹, I expressed the opinion that Milne-Edwards' species, *L. reynaudi* and *L. typus*², could not be recognised with any certainty from the original descriptions and that Dana's work, published in 1852³, must form the basis of our classification. So far as Milne-Edwards' *L. reynaudi* is concerned, this view had already been adopted by Faxon in 1895.⁴

Owing to lack of material for comparison, my account of the species represented in Mr. Gardiner's collection contains one serious misstatement. The specimens referred to Dana's *L. reynaudi* were said to be specifically distinct from others, obtained on the Ceylon coast, that I identified as *L. typus*, auct. Examination of

¹ Kemp, *Trans. Linn. Soc., Zool.* (2), XVI, p. 57 (1913).

² Milne-Edwards, *Hist. nat. Crust.*, II p. 469 (1837).

³ Dana, *U.S. Explor. Exped., Crust.* I, p. 668 (1852).

⁴ Faxon, *Mem. Mus. Comp. Zool., Harvard*, XVIII, p. 214 (1895).

further material from Indian waters has, however, convinced me that the characters on which I relied for the separation of the two forms are inconstant.¹ *L. typus*, auct. is therefore, as Ortmann pointed out in 1893², synonymous with Dana's *L. reynaudi* and, in view of the uncertainty that exists regarding the correct application of the former name, the species should, in my opinion, be known as *L. reynaudi* (Milne-Edwards) Dana.³

Three species of *Lucifer* are to be found in the Bay of Bengal. Specimens in the Indian Museum, collected for the most part by the R.I.M.S. 'Investigator,' are from the following localities:—

Lucifer acestra, Dana (= *L. reynaudi*, Bate⁴ and Ortmann⁵).

Lat. 10°15' N., long. 90°15' E.; about 1800 fms. Mid-water net, 375 fms. to surface.

Lat. 9°8' N., long. 87°25' E.; 1000 fms. Mid-water net, 475 fms. to surface.

Lucifer reynaudi (Milne-Edwards) Dana (= *L. typus*, Bate⁶ and Ortmann⁵).

Lat. 10°48' N., long. 75°, 1' E.; 500 fms. Surface net.

Lat. 12°40' N., long. 98°26' 30" E.; 10 fms. Surface net.

Lat. 11°57'30" N., long. 98°19' E.; 7 fms. Surface net.

Mergui Archipelago.

Off Ceylon coast.

Lucifer hanseni, Nobili.

Lat. 10°48' N., long. 75° 1' E.; 500 fms. Surface net.

Lat. 12°55'15" N., long. 98°27' E.; 12 fms. Surface net.

Lat. 12°40' N., long. 98°26'30" E.; 10 fms. Surface net.

Lat. 11°57'30" N., long. 98°19' E.; 7 fms. Surface net.

Lat. 11°58'20" N., long. 98°18'15" E.; 8 fms. Surface net.

Mergui Archipelago.

E. of Diamond I., mouth of Bassein R., Burma.

L. reynaudi and *L. hanseni* were frequently found in the same haul.

The only species of *Lucifer* obtained in the Chilka Lake is *L. hanseni*, which

¹ As regards the differential characters mentioned in my previous paper (*loc. cit.*, 1913, p. 60), I find on further examination that the pair of fine spinules that occur in the male behind the posterior tooth on the ventral margin of the last abdominal somite are sometimes present, sometimes rudimentary and sometimes entirely absent. The difference observed in the proportions of the outer uropod is apparently due to age, the segment being proportionately narrower in young individuals.

² Ortmann, *Decap. Schizop. Plankton-Exped.*, p. 40 (1893).

³ Since this paper went to press I have received a copy of Mr. Borradaile's recent note on the species of *Lucifer* [*Ann. Mag. Nat. Hist.* (8), XVI, p. 226 (1915)]. Mr. Borradaile, relying on the accuracy of figures published by a number of authors (a procedure that, in the case of the 'Challenger' Report at least, seems decidedly perilous), has introduced no less than six new species, of several of which he has apparently not seen specimens. Nobili's *Lucifer hanseni*, doubtless owing to an oversight, is omitted. I regret that in the account here given I have not dealt more fully with the individual variation of *L. hanseni* and with the differences which exist between young and old specimens. Such variation is probably considerable throughout the genus (see footnote above) and, until it has been studied in detail, the multiplication of specific names by such methods as Mr. Borradaile has adopted is to be deprecated.

⁴ Bate, *Rep. 'Challenger' Macrura*, p. 466, pl. lxxxiv (1888).

⁵ Ortmann, *loc. cit.*, p. 40.

⁶ Bate, *loc. cit.*, p. 464, pl. lxxxiii (1888).

occurs abundantly in fresh and brackish water and is evidently able to tolerate great changes in salinity.

Lucifer hanseni, Nobili.

1905. *Lucifer hanseni*, Nobili, *Bull. Mus. d'Hist. nat., Paris*, p. 394.

1906. *Lucifer hanseni*, Nobili, *Ann. Sci. nat., Zool.*, (9), IV, p. 25, pl. ii, fig. 1, and text-figs. 3b, p. 27.

The specimens from the Chilka Lake, along with others obtained by the 'Investigator' in various parts of the Bay of Bengal, undoubtedly belong to this species. *L. hanseni*, as Nobili has remarked, is closely allied to Dana's *L. reynaudi* (= *L. typus* of Nobili and other authors); but his table for their separation is in some respects misleading. Judging from the material in the Indian Museum the principal distinctions between the two forms are as follows:—

L. hanseni, Nobili.

'Neck' shorter; in female from $2\frac{1}{5}$ to $2\frac{1}{4}$ times, in male twice or less than twice the length of remainder of carapace.

Eyes not quite reaching distal end of basal antennular segment.

Abdominal segments with a spine above base of pleopods in very large males only.

Sixth abdominal somite from 2 to $2\frac{1}{3}$ times as long as deep, without or with only a very small postero-dorsal spine (text-figs. 37a, b).

Anterior spine on ventral margin of sixth abdominal somite of male situated much nearer to posterior spine than to anterior margin of segment; no spinules behind posterior spine. The same margin in female unarmed, rarely with a pair of fine spinules placed posteriorly (text-figs. 37a, b).

Spine at distal end of outer uropod not nearly reaching to distal end of segment (text-figs. 37c, d).

L. reynaudi (Milne-Edwards) Dana.

(= *L. typus*, Bate, Ortmann, Nobili.)

'Neck' longer; in female from $2\frac{1}{2}$ to $2\frac{3}{4}$ times, in male about $2\frac{1}{3}$ times the length of remainder of carapace.

Eyes reaching to or beyond distal end of basal antennular segment.

Abdominal segments with a strong spine above base of pleopods in both sexes.

Sixth abdominal segment from $2\frac{1}{2}$ to 3 times as long as deep, with a more conspicuous postero-dorsal spine (text-figs. 38a, b).

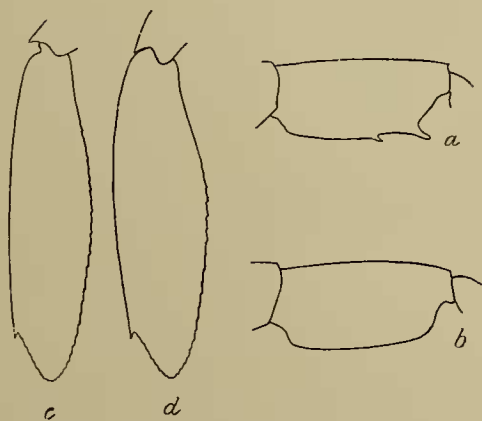
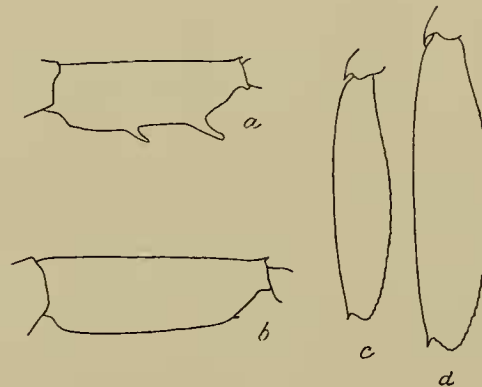
Anterior spine on ventral margin of sixth abdominal somite of male situated almost midway between posterior spine and anterior margin of segment; a pair of fine spinules frequently present behind posterior spine. The same margin in female always provided with a pair of fine spinules placed posteriorly (text-figs. 38a, b).

Spine at distal end of outer uropod reaching almost to, or in young males beyond, distal end of segment (text-figs. 38c, d).

In addition *L. hanseni* is decidedly stouter in build and the antennal scale is broader (about 9 times as long as broad in *L. hanseni* as compared with 11 times as long as broad in *L. reynaudi*). The 'phymocerite' at the base of the antennae is certainly present in some specimens of *L. hanseni*; but in others it appears to be missing.

In practice the most useful of the characters noted above is the difference in the form of the outer uropod. The position of the spine on the external margin is a valuable aid to identification in the species of *Lucifer*; in *L. ancestra* it is different from both the species mentioned above, extending in both adults and young far beyond the apex of the lamella.

Lucifer hanseni occurred in shoals in the Chilka Lake and was abundant in the main area at all times of the year, existing in water of specific gravity varying from 1.000 to 1.0150. In the outer channel it was common in September in fresh water; but was extremely scarce in March when the water was as salt as the Bay of Bengal near the lake (sp. gr. 1.0265). If the only data available were those obtained in the Chilka Lake, one would suspect that the species preferred a low salinity and that it was only by chance that it came in contact with sea-water. But the species, as will be seen from the records on p. 323, is common in the Bay of Bengal and was on one occasion found in nets fished in mid-water over a sounding of 500 fathoms. I am

FIG. 37.—*Lucifer hanseni*, Nobili.FIG. 38.—*Lucifer reynaudii*, M.-Ewd. (Dana).

- a. Last abdominal somite of male, in lateral view,
- b. do. of female, in lateral view.
- c. Outer uropod of male.
- d. Outer uropod of female.

unable to offer any explanation of the scarcity of the species in the outer channel in March.

Young post-larval specimens were found on a number of occasions in the fresh-water season, but I am not convinced that the species actually breeds in the lake; the young individuals obtained may have grown from larvae brought into the lake from the sea some months earlier. Specimens from the lake are on the whole decidedly smaller than those obtained in the Bay of Bengal; the largest individuals from the Chilka Lake scarcely reach 8 mm. in length, whereas those from the 'Investigator' collections frequently exceed 11 mm.

Apart from the specimens from the Chilka Lake and from those recorded on p. 323, *Lucifer hanseni* is known only from the Red Sea.